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J. F. KELLY, *Editor*

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Coming Meetings and Papers

PHILADELPHIA SECTION— A. I. & S. E. E.

SATURDAY, OCTOBER 25, 1930

VACUUM TUBES IN A NEW FIELD

"HOW AND WHY TUBES ENTER THE INDUSTRIAL FIELD," W. C. WHITE, Engineer in Charge, Vacuum Tube Engineering Department, General Electric Company, Schenectady, N. Y.

"APPLICATION OF VACUUM TUBES IN THE STEEL INDUSTRY," W. R. KING, Vacuum Tube Specialist, Industrial Engineering Department, General Electric Company, Schenectady, N. Y.

SATURDAY, DECEMBER 6, 1930

"THE INFLUENCE OF MODERN ELECTRICAL EQUIPMENT DESIGN ON BRUSH PERFORMANCE." WILLIAM SIEBENMORGEN, Electro Service, Inc., Union City, N. J.

SATURDAY, JANUARY 3, 1931

LUBRICATION MEETING

"AUTOMATIC LUBRICATION IN STEEL MILLS," HORACE B. CLEAVELAND, Lubrication Engineer, Bethlehem Plant, Bethlehem Steel Company, Bethlehem, Pa.

SATURDAY, FEBRUARY 7, 1931

"ANNEALING IN ARTIFICIAL ATMOSPHERES IN ELECTRIC FURNACES," HORACE DREVER, Gas Equipment Engineering Corporation, Philadelphia, Pa.

A special invitation to attend this meeting is extended to the Members of the Philadelphia Chapter, American Society for Steel Treating.

SATURDAY, MARCH 7, 1931

"SOME IMPRESSIONS OF A WELDING SUPERVISOR IN A STEEL MILL—IN A MANUFACTURING PLANT," J. C. CUMBERLAND, Superintendent of Welding, A. S. Cameron Steam Pump Works, Phillipsburg, N. J.

A special invitation to attend this meeting is extended to the Members of the Philadelphia Section, American Welding Society.

SATURDAY, APRIL 4, 1931

"GENERAL IDEAS AND DISCUSSION." Every Active Member is invited to prepare a short paper on a subject pertaining to the application of electricity to the iron and steel industry. Some of the papers to be presented are as follows:

"SERIES LIGHTING IN THE STEEL PLANT," E. L. ANDERSON, Electrical Department, Bethlehem Steel Company, Sparrows Point, Md.

"FIRE HYDRANT," GEORGE PFEFFER, Chief Electrician, Florence Pipe Foundry & Machine Company, Florence, N. J.

"AIR CONDITIONING EQUIPMENT," WALTER H. BURR, Superintendent, Electrical Department, Lukens Steel Company, Coatesville, Pa.

FRIDAY, MAY 1, 1931

INSPECTION TRIP

RIVERSIDE METAL COMPANY, RIVERSIDE, N. J.
FLORENCE PIPE FOUNDRY & MACHINE COMPANY, FLORENCE, N. J.

JUNE 15TH TO 19TH, 1931

ANNUAL CONVENTION, CLEVELAND AUDITORIUM, CLEVELAND, O.

All meetings, unless otherwise noted, will be held in the Engineers' Club, 1317 Spruce Street, and will start promptly at 7:00 P. M. They will be preceded by an informal dinner at 6:00 P. M.

The privileges of the Engineers' Club are at the disposal of the members on the day of the meeting. Make the Club your headquarters.

ATTEND every meeting and bring your friends.

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J. Earl Montgomery, Vice President and General Manager of Wheeling Steel Corporation, who has invited the members and guests of the Association of Iron and Steel Electrical Engineers to visit the Steubenville Works of the Wheeling Steel Corporation, on December 3rd, 1930. One of the features of the trip will be the inspection of the largest continuous Strip-Sheet Plate Mill in the world.

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Electrical Apparatus for the Coreless Induction Furnace

By N. R. STANSEL

An induction furnace is a transformer. The general case is a primary circuit supplied with power at constant voltage and constant frequency, and a short-circuited secondary circuit formed by a charge of metal in refractory crucible. The output of this transformer is heat developed by currents induced in the secondary circuit.

The term "core type" induction furnace designates an induction furnace which has an iron core to form the magnetic circuit. A diagram of a design of this type of furnace is shown in Fig. 1. Cor-

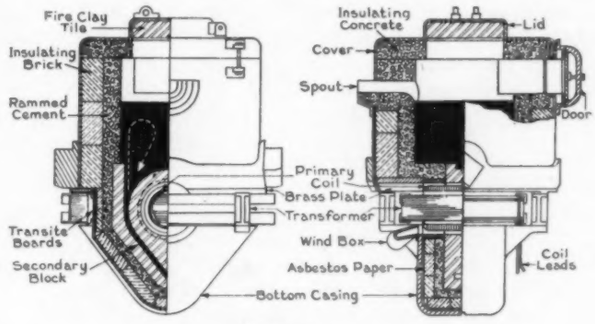

FIG. 1.

respondingly the term "coreless" is applied to the type of induction furnace which has no iron in its magnetic circuit. This type in elementary form consists only of a container—or crucible—a primary coil, and a supporting structure as illustrated by the diagram of Fig. 2.

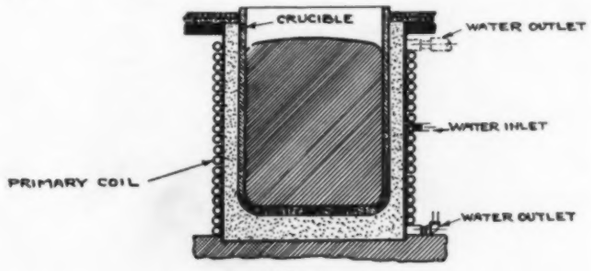

FIG. 2.

In the core type furnace there is a large magnetic flux and a slow change in that flux, i.e., a low frequency. The magnetic flux of a coreless induction furnace is small and the change in that flux is rapid, hence the term "high frequency" as used generally in referring to that type of furnace.

Referring to Fig. 2, the alternating magnetic flux developed by the current in the primary coil penetrates the charge of metal in the crucible and currents are thereby induced in the metal. (If the material to be heated is not an electrical conductor the crucible must be made of a conducting material, such as graphite, to serve as the secondary circuit of the transformer.) -The flux density in the body of the metal falls off rapidly towards the vertical axis as indicated by the logarithmic curve C of Fig.

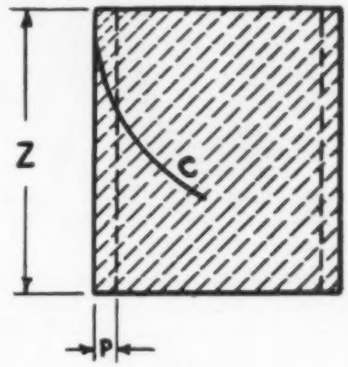

FIG. 3.

3, so that at a comparatively short distance from the side surface the flux density is very small. We can substitute for the actual area of the magnetic path within the charge of metal an equivalent area, l x p, Fig. 3, which with a uniform flux density would give the same total magnetic flux as exists in the body of the metal. The value of p thus defined is termed the "depth of penetration" of alternating magnetic flux in the metal. The value of p for a given case is obtained by the equation [2],

$$p = \frac{3570}{\sqrt{f \mu \lambda}} \qquad (1)$$

in which,

p = depth of penetration in cms.
f = frequency
μ = magnetic permeability of the metal
λ = electrical conductivity of the metal

Table I gives values of p at different frequencies for copper, zinc, brass and soft iron. The conductivities of metals vary with temperature and ferrous alloys are non-magnetic above the critical range. Hence for all metals and their alloys at elevated temperatures the depth of penetration for a given frequency is a function of temperature.

TABLE I

Value of p in centimeters

Frequency	25		60		500		1000		10000	
	Solid	Molten	Solid	Molten	Solid	Molten	Solid	Molten	Solid	Molten
Copper	0.92	3.22	0.60	2.12	0.20	0.70	0.15	0.51	0.05	0.16
Zinc	1.75	4.13	1.13	2.66	0.39	0.93	0.28	0.65	0.09	0.21
Brass	1.75	4.74	1.13	3.05	0.39	1.06	0.28	0.75	0.09	0.24
Iron (x)	0.10	10	0.07	7	0.024	2.4	0.017	1.7	0.005	0.50

*General Electric Company.

1. This article refers only to power sizes of coreless induction furnaces, 50 KW and above.

2. Steinmetz, Transient Phenomena and Oscillations. Chap. VI, 1909 Ed.

X. Resistivity in molten state 200 microhms per cm. cube assumed.

As the e.m.f. developed with a given frequency at any point within the mass of a charge of metal is proportional to the magnetic flux at that point, the current densities measured along the horizontal axis of the charge will give, in graphic form, a logarithmic curve similar to curve C of Fig. 3. Hence in lieu of referring to the depth of penetration of alternating magnetic flux in the charge we can refer to the depth of penetration of the currents which circulate in the body of the metal.

The total current in the charge is the product of the average current density and the area of the cross-section of the path of the current. The value of p now represents current density in the charge and the area, l x p. Fig. 3, is the cross sectional area of a conductor equivalent in electrical resistance and reactance to those values for the actual path of current in the charge. It will be noted, therefore, from the values of p in table I, that the development of heat in a charge of metal in a coreless induction furnace is concentrated largely in a comparatively thin shell of metal around the charge. This shell of metal, in effect, forms the secondary circuit for the transformer function.

When an alternating current in the primary coil of a furnace reaches its maximum value, I_m, the total electromagnetic energy stored in the space contiguous to the coil is

$$W = \frac{L_s I^2_m}{2} \qquad (2)$$

in which,

W = watt-seconds

L_s = the coefficient of self-induction of the coil

I_m = the maximum value of the current during the half-cycle.

A certain part of this energy enters the charge of metal in the crucible. This part is,

$$W^1 = \frac{\theta L_s I^2_m}{2} \qquad (3)$$

in which

θ = the fraction of the total electromagnetic energy which is absorbed by the charge.

The power input to the charge for a given frequency f, is,

$$P^1 = 2 f W^1 \qquad (4)$$

substituting equation (3) in equation (4) we have

$$P^1 = \theta L_s f I^2_m \qquad (5)$$

For a sine wave $I^2_m = 2 I^2$, hence

$$P^1 = 2 \theta L_s f I^2 \qquad (6)$$

As the rate of heating of the charge is proportional to the power input to the charge equation (6) states that the rate of heating of a charge of metal in a coreless induction furnace is proportional to the square of the current in the primary coil and to the frequency.

There is a certain amount of heat developed in the primary coil of the furnace by the current in that coil. Also the primary coil receives heat from the charge by conduction through the wall of the crucible. The primary coil in the standard type coreless induction furnace is water-cooled and the current in this coil is limited by the rate at which the heat can be removed by the cooling water. A second limitation is the electrical insulation between turns of the coil. A third limitation to the amperes in the primary coil is the electro-dynamic action on the charge after the molten state is reached. The stirring effect in the molten metal thus produced is proportional to the square of the ampere turns of the primary coil. The heating effect is proportional to both the frequency and the square of the ampere turns. Thus, in each case, the conditions of the problem of design fix within certain limits the value of the current in the primary coil.

The transfer of energy by electromagnetic induction from the primary circuit to the secondary circuit, i.e., to the charge, introduces no strains in the apparatus and there is no loss due to this method of transfer. Hence, theoretically, there is no upper limit to the frequency, i.e., there is no theoretical limit to the rate at which a charge can be heated in this type of furnace. The actual upper limit of the frequency is an economic consideration in which the cost of the equipment is balanced against the value of speed of melting metal.

The minimum frequency which gives effective transfer of energy from the primary coil to the charge is a function of the diameter of the charge and of its resistivity. This relation is expressed by Northrup [3] in the equation,

$$f_k = \frac{2500 \times \rho}{d^2} \qquad (7)$$

in which

f_k = the knee value of frequency corresponding to given values of ρ and d.

ρ = resistivity of the charge in microhms per centimeter cube.

d = diameter of the charge in centimeters.

The value f_k in equation (7) marks the knee of the curve which shows the relation between heating efficiency and the square-root of frequency for a given diameter of charge. This general characteristic is shown in Fig. 4. Below the value f_k in a given case the heating efficiency falls off rapidly.

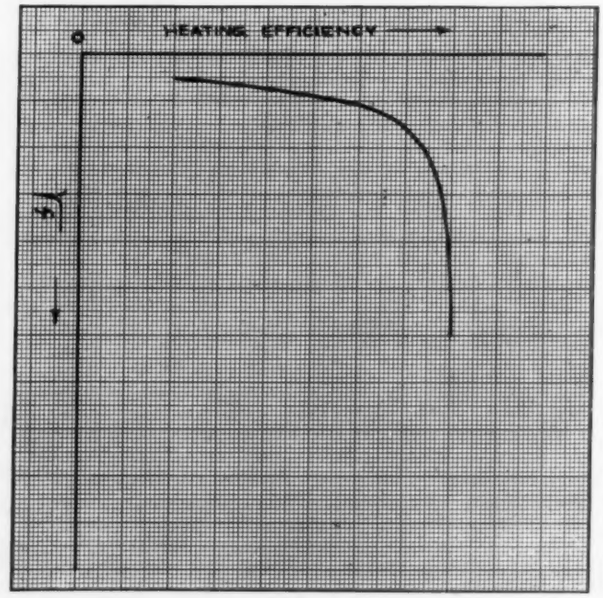

FIG. 4.

3. See Patent No. 1,694,792. E. F. Northrup, High Frequency Induction Furnace.

Raising the frequency above the value f_k improves this efficiency only slowly.

In any case the frequency must be high enough to give a power input sufficient to heat the charge to the desired temperature and also high enough to carry the charge to the desired temperature in the desired time. All other conditions being the same the more effective the heat insulation of the furnace the lower will be the frequency required to meet this dual requirement.

Thus the selection of ampere turns, voltage and frequency for a given use of this induction method of heating is a joint technical and economic problem in design. The remarkable results in melting metals obtained through this use of frequency as a tool illustrates a new viewpoint in our conception of the use of electric energy. It further illustrates the trend in present day engineering; the crystallization of theory into economic industrial procedure.

The frequencies in use for coreless induction furnaces, in sizes 50 KW and above, in metal melting service range from 480 cycles to 2000 cycles. A frequency of 960 cycles has been adopted as standard for steel melting furnaces in sizes up to 1000 KW.

The corresponding voltages in use range from 440 to 1800 volts. The standard for the 960 cycle steel melting furnace is 800 volts.

The initial resistance of the secondary circuit of the coreless induction furnace is a function of the specific resistance of the metal of the charge and of the contact resistances between the pieces of the charge which are adjacent to inner side of the crucible and which by contact, piece to piece, complete the secondary circuit. As the temperature of the charge rises the specific resistance of the metal increases. The marked increase in the specific resistance of a metal at the melting point, see Fig. 5, is

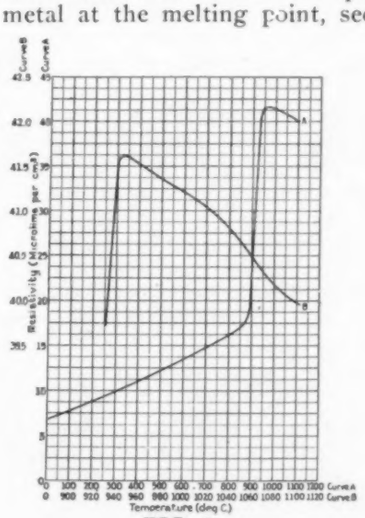

FIG. 5.

more than offset by the elimination at that temperature of the contact resistances in the secondary circuit. Charges of metal vary widely in character but the general load characteristic of this type of furnace with constant voltage and constant frequency is an increasing power input as the temperature of the charge rises.

The coreless induction furnace is inherently a single phase load. One arrangement of equipment is the unit combination of a furnace and a single phase generator. However, the generators for this service can be wound either two phase or three phase and two or more furnaces balanced on the phases. The stators of single phase generators, 100 KW and below, are wound single phase. Larger machines, as a general rule, are wound three phase and any two leads are used for single phase service. Two or more generators, single phase or polyphase, can be operated in parallel to supply one or more

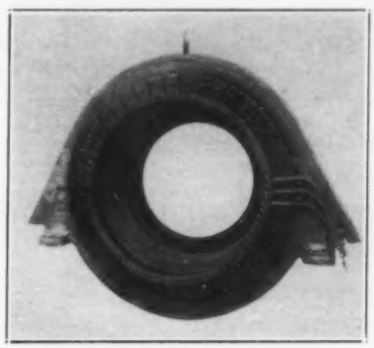

FIG. 6.

furnaces. In general the flexibility of generators for this service is the same as that of 60 cycle machines.

A typical stator of a generator of this class of machines is shown in Fig. 6. Figs. 7 and 8 illustrate

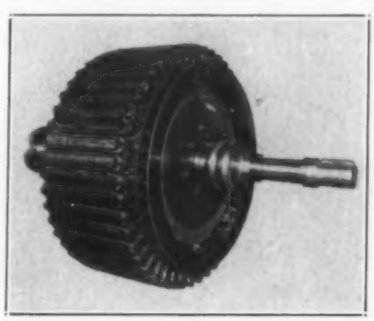

FIG. 7.

typical rotors. The magnetic structure of 42 pole 1200 r.p.m. rotor is shown in Fig. 9. Complete frequency changer sets are shown in Figs. 10 and 11. The sizes of these sets so far built are within the range of 60 KVA to 750 KVA. All of these generators are of the salient pole type and, in the majority of cases, the generators are designed for operation at 0.90 p.f.

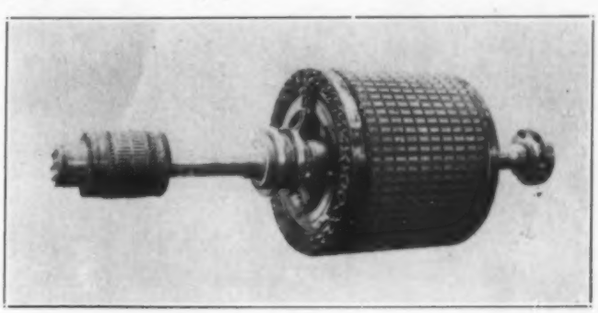

FIG. 8.

The particular features of design of these generators which are made necessary by the special

frequency are: more active material, thinner laminations in the magnetic structure, and a larger area of ventilating ducts, than would be required for corresponding 60 cycle generators. There is no special requirement as to wave form. The wave forms ob-

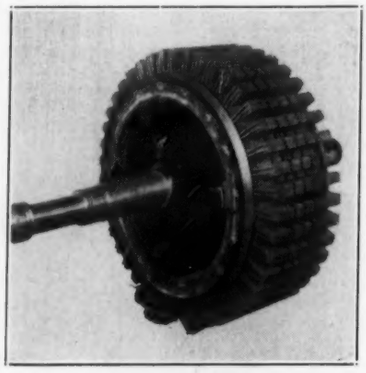

FIG. 9.

tained are very much the same as those of standard 60 cycle machines.

Any type of motor can be used to drive the generator. As a rule sets up to 150 KW have induction motor drive; above that size the driving motor is usually of the synchronous type and is

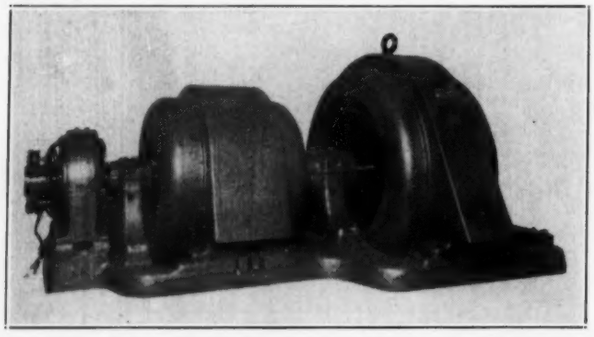

FIG. 10.

built for operation at unity power factor or at whatever leading power factor may be needed for power factor compensation service in the power supply system. Sets with synchronous motors usually have two direct connected exciters, one for the generator and one for the motor.

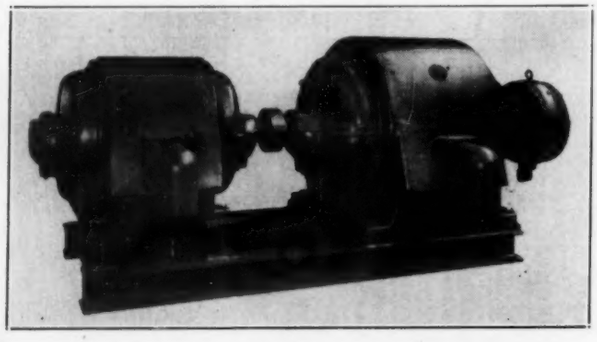

FIG. 11.

The efficiency of this class of generator is somewhat lower than that of a corresponding 60 cycle generator. This is due mainly to the higher excitation required for the higher frequency machine. The input—output full load efficiency of a set made up of a 200 KW 0.90 p.f. 960 cycle 800 volt single phase generator and a three phase 60 cycle induction motor is 81 per cent. Larger units show higher efficiencies.

The load characteristic of the coreless induction furnace—noted in a preceding paragraph, makes it necessary to provide some method of voltage adjustment for the furnace circuit. The unit combination of furnace and generator is very convenient for this purpose. Where two or more furnaces are supplied from one generator the voltage adjustment for each furnace is provided by either an induction regulator, autotransformer with taps or choke coil as may be best suited in each case. Taps on the furnace coil

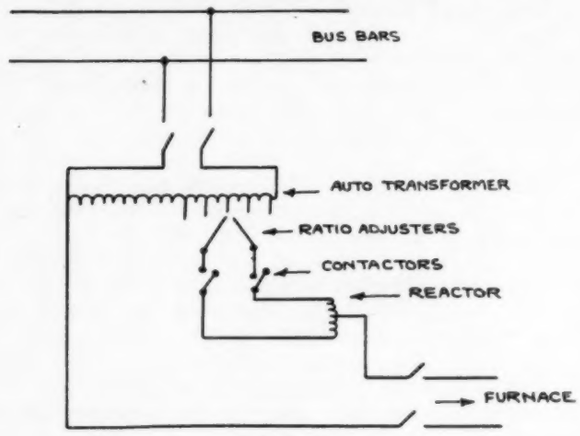

FIG. 12.

are also used for this purpose. The diagram of Fig. 12 illustrates the use of an autotransformer with the standard type load ratio control equipment for changing taps under load.

Instruments and meters for frequencies up to 2000 cycles are of the types used in 60 cycle circuits. Each instrument, meter, and transformer must be calibrated for the particular frequency of the circuit. The switchgear is not affected by the frequency except in the calibration of coils and by the precautions that must be taken to avoid heating of metal parts, such as oil circuit breaker frames, etc., by eddy currents. The voltage regulator for the generator is of the standard type with the addition of a capacitor in series with the alternating current coil.

The power factor of the coreless induction furnace is low, 5 to 15 per cent. This introduces the economic problem of power factor correction. At the frequencies used the capacitor is more efficient, requires less capital expenditure, and has lower operating and maintenance costs than synchronous condensers.

A capacitor is designed, fundamentally, for a given micro-farad rating for operation at a given voltage. The voltage rating determines the thickness of the dielectric, or insulation, between the metal plates, or electrodes.[4] The micro-farad rating

4. The dielectric strength, i.e., the breakdown voltage per centimeter thickness, decreases with increase in the thickness of a dielectric material.

for a given thickness of dielectric depends on the area of the electrodes. With the same electrode area and the same thickness of dielectric the micro-farad rating depends on the dielectric constant, K, i.e., the specific inductive capacity, of the dielectric material.

The relation between the kva of a capacitor and the frequency, capacity and voltage is expressed by the following equation,

$$\text{kva} = \frac{2\pi f c E^2}{10^9} \qquad (8)$$

The capacity for kva is,

$$\text{c per kva} = \frac{10^9}{2\pi f E^2} \qquad (9)$$

in which

f = frequency
c = micro-farads
E = volts—r.m.s. value.

The effect of voltage on the size of a capacitor is more readily seen by the comparison of table II.

TABLE II

Frequency 60 Cycles

Voltage	Mf per kva
110	220
220	55
440	13.7
2200	0.55

Table III is the comparison between frequency and micro-farads per kva.

TABLE III

Voltage 1000 Volts

Frequency	Mf per kva
60	2.60
120	1.30
240	0.65
480	0.325
960	0.1625
1920	0.08125

Capacitors for power service are made of carefully selected paper in thickness of 0.0004 and 0.0005 inch and aluminum foil in thickness of 0.0003 and 0.0005 inch. The required thickness of dielectric is built up of sheets of this very thin paper, thus giving a laminated structure which has a much higher dielectric strength than can be obtained with a single sheet of paper of the same thickness as the total thickness of the number of sheets in the laminated structure.

Both the paper and the aluminum foil are obtained in rolls and the sections of a capacitor unit are formed by winding the paper and the foil, alternate layers of paper and a layer of foil, on a machine of the type shown in Fig. 13. Connections to the electrodes are made by means of tap straps of aluminum sheet, which are thicker than the foil, placed at equidistant points along the electrode during the winding operation.

After removal from the winding machine the composite roll of paper and aluminum foil is collapsed to form a section of a capacitor unit as shown in the interior view of a partially completed capacitor, Fig. 14. The sections are placed in a metal tank, or can, and given a drying and oil impregnation treatment. This treatment is second in importance only to the selection and control of the materials, paper, aluminum foil, and oil, of which the capacitor is made. Filling the tank with oil, sealing and testing complete the construction of the capacitor.

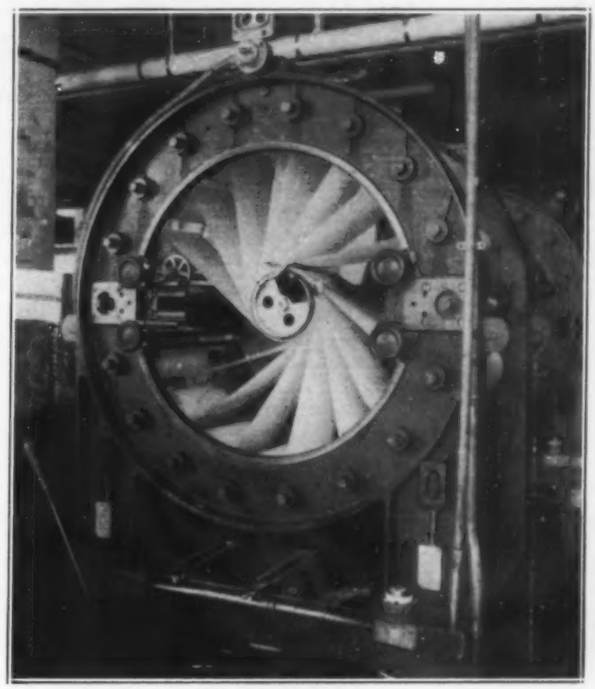

FIG. 13.

The power factor of the oil-paper—aluminum capacitor is 0.20 per cent or lower at 60 cycles. This means that a 5 kva capacitor, for example, has a loss of 10 watts or less when operated at 60 cycles. The power factor increases with an increase in frequency but this increase is neglible up to about 500

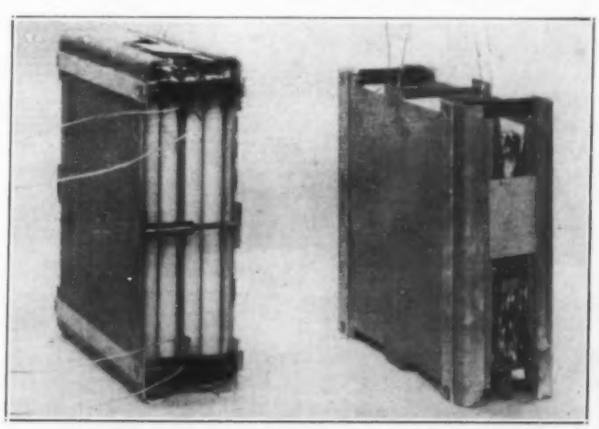

FIG. 14.

cycles. At 2000 cycles the power factor is about 0.30 per cent. An increase in temperature increases the loss in a capacitor and also decreases the dielectric strength.

The frequency is a relatively unimportant factor in the design of 60 cycle capacitors. Here the limiting factor is the voltage stress. For example, in the case of the 5 kva 60 cycle unit the temperature rise due to the loss of 10 watts is only 3 or 4

deg. C., neglible as regards its effect on the capacitor. If this unit is operated at 2000 cycles at the same voltage the kva becomes $\frac{5 \times 2000}{60} = 167$ kva. The power factor is now about 0.30 per cent and the loss (in the same volume of dielectric) is 500 watts. Under this condition the unit would soon be destroyed by heat.

Capacitors for the higher frequencies must be designed on the basis of the loss from a given volume of dielectric. It is not practicable to hold the temperature rise of these units to the low value obtained with 60 cycle capacitors; however, the maximum temperature rise for a given rating is kept below 25 deg. C. and the same factor of safety against breakdown as used for 60 cycle units is maintained. An important feature in the construction of high frequency capacitors is the means used for dissipation of the comparatively large amount of heat developed in the material. For 60 cycle capacitors, for which heat dissipation is not important, the width of the aluminum foil is less than the width of the paper, i.e., the foil is buried in the paper. In construction of the high frequency capacitor the aluminum foil is wider than the paper, i.e., each edge of the foil is in contact with the oil and good conduction of heat from the interior of the unit to the surrounding oil is obtained.

Another factor that must be taken into consideration in the design of high frequency capacitors is the decrease in the dielectric strength of insulating materials due to frequency alone. For example, at a constant temperature and for the same time period of test voltage the dielectric strength of a given material at 2000 cycles is less than 75 per cent of its dielectric strength at 60 cycles.

These several considerations form the basis of the design of capacitors for the frequencies and voltages of coreless induction furnace service. A standard rating of a capacitor unit of this class is 9.12 mf. This unit has the dimensions: height 15 inches, floor space 13½ by 4⅛ inches. The net weight is 45 pounds. For a given frequency and given voltage, within the range of the design, the kva at which this unit can be operated depends on the method of cooling. The standard assembly is a number of capacitor units in a tank of oil with pipe coils for the circulation of cooling water. This method gives a compact installation and with an adequate supply of cooling water permits the use of the full kva rating given by equation (8) and without undue temperature rise.

The power factor of the furnace circuit varies during the heat cycle. This requires a corresponding variation in the capacity connected in the circuit to maintain the power factor of the generator circuit at or near unity. This is accomplished by the use of an automatic power factor controller which controls a group of contactors in the individual circuits to the tank of capacitor units.

The bus connections to the capacitors should be laid out for approximately equal lengths to all units so as to obtain approximately equal inductances. Inductance in series with capacity gives a rise in voltage on the capacity equal to the inductive drop and if the inductances of the circuits are unequal the voltages applied to the capacitors will be unequal.

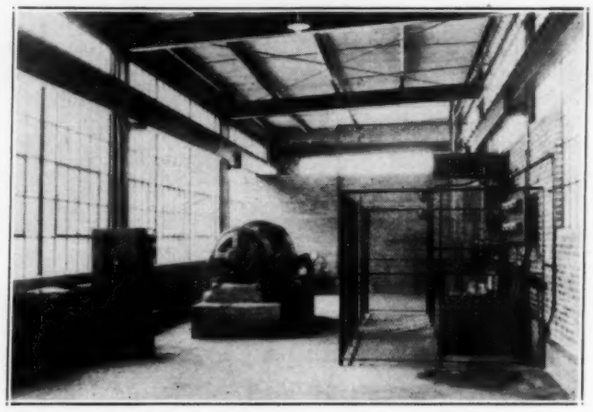

FIG. 15.

Fig. 15 is from a photograph of an installation of a 150 KW 960 cycle 800 volt frequency changer set, switchgear, and capacitors, which supplies a steel melting furnace. The water cooled capacitor tank is adjacent to the wall which separates the apparatus room from the furnace room.

SECOND LINCOLN ARC WELDING PRIZE COMPETITION OFFERS OPPORTUNITIES FOR ENGINEERS AND DESIGNERS

The Second Lincoln Arc Welding Prize Competition offers engineers and designers substantial rewards for their skill and ingenuity in utilizing the advantages of arc welding in the redesign of any present product or in the design of any proposed product or structure. For the forty-one best papers describing this work $17,500.00 will be awarded by The Lincoln Electric Company, Cleveland, Ohio.

The prizes for the first six best papers will range from $7,500 to $250. From the seventh to forty-first, $100 each.

The Jury of Awards, who will judge the papers entered in this Competition, will be composed of the faculty members of the Electrical Engineering Department of Ohio State University under the chairmanship of Professor Erwin E. Dreese, head of the department and such others as he may select.

The purpose of the Second Lincoln Arc Welding Prize Competition, as announced by its sponsors, is to stimulate engineers and designers in every line of industry to think of the manufacture of their own products by the use of Arc Welding and to increase their knowledge of the feasibility of its application.

The Competition is open to any person in the world except the employees of the sponsors. The closing date for the Competition is October 31, 1931. For complete details of the rules governing the Competition address:

The Lincoln Electric Company, P. O. Box 683, Cleveland, Ohio.

LUBRICATION ENGINEERING DIVISION

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS

QUESTIONNAIRE—STEEL MILL LUBRICATION PRACTICES

The Executive Committee of the Lubrication Engineering Division of the Association of Iron and Steel Electrical Engineers held their first meeting at the Lackawanna, N. Y., plant of Bethlehem Steel Company, October 3, 1930. The following preamble and program was adopted as a start toward the advancement of the application of lubrication in the Iron and Steel Industry. The Executive Committee is as follows:

CHAIRMAN, C. C. Pecu, Lub. Engr., Bethlehem Steel Company, Lackawanna, N. Y.; Secretary, T. B. Little, Association of Iron and Steel Electrical Engineers, Pittsburgh, Pa.

A. D. Adams, Asst. Gen. Supt., Spang Chalfant Co., Inc., Ambridge, Penna.

D. B. Geeseman, Gen. Mgr., Standard Tin Plate Company, Canonsburg, Pa.

J. A. Clauss, Chief Engr., Great Lakes Steel Company, Ecourse, Mich.

Vic Chartner, Chief Engr., Pittsburgh Steel Company, Monessen, Penna.

C. E. Bedell, Chief Engr., Wheeling Steel Corporation, Benwood, W. Va.

J. J. Booth, Electrical Supt., National Tube Company, Gary, Indiana.

J. D. Donovan, Elec. and Mechanical Supt., Republic Steel Corp., Massillon, O.

N. C. Bye, Chief Engr., Henry Disston & Sons, Inc., Tacony, Philadelphia, Pa.

C. A. Bollinger, M.M., American Sheet and Tin Plate Company, New Castle, Pa.

F. J. Binckes, Asst. Chief Engr., Inland Steel Company, Indiana Harbor, Ind.

C. A. Baumann, Chief Mech. Engr, Carnegie Steel Co., Clairton, Penna.

J. C. Green, Asst. Engr., Pittsburgh Crucible Steel Co., Midland, Pa.

H. G. Gibson, M.M., McKeesport Tin Plate Co., McKeesport, Penna.

C. J. Duby, Asst. Chief Engr., Republic Steel Corp., Warren, Ohio.

Gordon Gage, Supt. Maintenance, American Rolling Mill Co., Butler, Pa.

Carl S. Walrab, M.M., Calumet Steel Company, Chicago Heights, Ill.

L. A. Wynd, M.M., Keystone Steel and Wire Co., Peoria, Illinois.

J. M. Faris, Asst. to Vice Pres., Youngstown Sheet and Tube Company, Youngstown, Ohio.

E. C. Kirkpatrick, Mech. Engr., Steel Co. of Canada, Montreal, Quebec, Canada.

L. F. Coffin, Gen. Master Mech., Bethlehem Steel Co., Sparrows Point, Md.

S. N. Roberts, Mech. and Elec. Supt., Atlantic Steel Company, Atlanta, Ga.

R. C. Mohler, Dist. Engr., American Steel and Wire Company, Pittsburgh, Pa.

Howard M. Miner, M.M., Follansbee Brothers, Toronto, Ohio.

H. F. Martin, Asst. M.M., Jones and Laughlin Steel Co., Aliquippa, Pa.

B. S. Burrell, Master Mechanic, Inland Steel Co., Indiana Harbor, Ind.

John F. Pelly, Bethlehem Steel Company, Bethlehem, Pa.

Samuel Roberts, Lub. Engr., Carnegie Steel Company, Homestead, Pa.

John M. Husher, Gen. Master Mech., Pittsburgh Steel Company, Monessen, Penna.

Lubrication Engineering Division

Object—the advancement of the application of lubrication to the Iron and Steel Industry. To promote the study and practice of steel mill lubrication and to accumulate and disseminate data secured in the field of operation.

Among the means to be employed to attain this end shall be the organization of a lubrication engineering division of the Association of Iron and Steel Electrical Engineers to function through specialized committees, periodical meetings for the presentation of papers and the discussion of lubrication subjects pertinent to the industry.

COMMITTEES AND THEIR FUNCTIONS

Executive Committee

The establishment of contacts with the executive personnel of the Iron and Steel Industry together with the mill and machinery builders and also the electrical manufacturers in the United States and Canada to secure information and data in connection with lubrication.

Engineering Committees

Design of mills, prime movers, power transmission equipment and machinery, with respect to lubrication.

1. Bearing Design
   - a. Bearing pressures
   - b. Effect of Velocity
   - c. Temperatures
   - d. Materials
   - e. Grooving

Records and Accounting

1. Consumption and cost of lubricants.
2. Maintenance cost through lubrication.
3. Mill delays.
   - a. Poor bearing design
   - b. Change of bearings
   - c. Lubrication devices
   - d. Lack of lubrication
4. Power costs and savings.
5. Comparative data and charts for periods lubrication used.
6. Storage and handling of oils and greases.
   - a. Methods used for ordering oils and greases
   - b. Methods used for storage
   - c. Are storage houses centrally located?
   - d. Should oils and greases be ordered on basis of tons rolled?

Proper application of lubrication appliances and devices

1. Automatic pressure systems
2. Circulating oiling systems.
3. Sight-feed and pressure cups
4. Pressure guns
5. Hand Methods
6. Safey Provisions.
7. Reconditioning of oil

Specifications of lubricants

1. Standardization of Practices.
2. Laboratory and mill tests.

Meetings

1. Technical sessions under the auspices of the Lubricating Engineering Division of the Association of Iron and Steel Electrical Engineers.
2. National Executive Committee Meetings, (approval, reports, policies, etc.)
3. Sectional Committee Meetings.
   - a. Preparation of data, information, reports, papers, etc.

The IRON AND STEEL ENGINEER, the official periodical of the A. I. & S. E. E. will carry exclusively the transactions of the Lubrication Engineering Division.

Lubrication Engineering Division Questionnaire
Steel Mill Lubrication Practices

STANDARD CRANES, TRAVELING, GANTRY, JIB AND DERRICK CRANES

Part	Method of Application	What Type of Lubrication Do You Recommend
Worm Gear Drives and Mechanical Brake	Splash Lubricated and Bath	
Spur Gears	Casing Covered (Hand Oiled) Open (Brush or Paddle)	
Roller Bearings, Plain Bearings	Grease Gun	
Track Wheel Bearings and other parts	Waste Packed or Hand Oiled or Grease	
Wire Ropes and Cables	Hand Oiled	
Electric Motors	Ring Oiled	

INGOT STRIPPERS, LADLE AND SOAKING PIT CRANES

Part	Method of Application	What Type of Lubrication Do You Recommend
Ingot Stripper Screw	Bath	
Driving Gears Worm Type	Splash	
Spur and Bevel Gears	Casing Covered (Hand Oiled) Open (Brush or Paddle)	
Slides		
Bearings	Grease Gun	
Bearings (Truck Wheels)	Waste Packed or Hand Oiled or Grease	
Wire Ropes and Cables	Hand Oiled	
Electric Motors	Ring Oiled	

CHARGING MACHINES

Part	Method of Application	What Type of Lubrication Do You Recommend
Worm Gear Drives	Splash Lubricated	
Spur Gears	Casing Covered (Hand Oiled) Open (Brush or Paddle)	
Roller Bearings	Grease Gun	
Bearings	Waste Packed or Hand Oiled	
Electric Motors	Ring Oiled	
Track Wheels	Waste Packed or Hand Oiled or Grease	

PINION STANDS AND TRANSMISSION GEAR SETS

Part	Method of Application	What Type of Lubrication Do You Recommend
MERCHANT AND ROD MILLS		
Pinion Stands		
Pinion and Pinion Necks	Circulation System	
Pinions	Splash	
Pinion Necks	Drop Feed or Hand Oiled	
Reduction Gear Sets		
Gears and Bearings	Circulation System	
Gears	Splash	
Bearings	Ring Oiled	
BAR, BILLET AND MEDIUM STRUCTURAL MILLS		
Pinion Stands		What Type of Lubrication Do You Recommend
Pinions and Pinion Necks	Circulation System	
Pinions	Splash	
Pinion Necks	Drop Feed	
	Hand Oiled	
Reduction Gear Sets		
Gears and Bearings	Independent Circulation One System for Gear Sets and Pinion Stands	
Gears	Splash	
Bearings	Ring Oiled	

BEVEL GEAR LINE SHAFT DRIVES

Part	Method of Application	What Type of Lubrication Do You Recommend
Bevel Gears and Bearings	Circulation or Splash	
Bevel Gears (Open)	Brush or Paddle	
Bearings	Hand Oiled	
	Independent Circulation	
	Drop Feed	
	Grease Cup, Gun	

UNIVERSAL, BLOOMING, RAIL, HEAVY STRUCTURAL, PLATE AND SLABBING MILLS

		What Type of Lubrication Do You Recommend
Pinion Stands		
Pinions and Pinion Necks	Circulation System	
Pinions	Splash	
Pinion Necks	Drop Feed	
	Hand Oiled	
Reduction Gear Sets		
Gears and Bearings	Circulation System	
Gears	Splash	
Bearings	Circulation, Ring Oiled	

ROLL STANDS—ALL TYPES OF MILLS

Roll Necks, Anti-Friction Bearings	Grease Gun	
Roll Necks, Plain Bearings Type		
Wood	Swab, Block or Pressure	
Brass	Swab, Block or Pressure	
Babbitt	Swab, Block or Pressure	
Other Bearings	Drop Feed	
	Hand Oiled	
	Bath	
Screw Downs	Drop Feed, Hand Oiled	
	Brush or Paddle	
Couplings, Sleeve or Flexible	Grease Gun	
Open Gears	Brush or Paddle	
Manipulators		
Electric Motors	Ring Oiled	
Gears and Racks	Splash Oiling	
	Hand Brush	
Bearings	Oil Cups and Hand Oiling	
Crank Shaft Bearings	Oil Cups—Grease Cups	

LUBRICATION OF TABLE ROLLS

Part	Method of Application	What Type of Lubrication Do You Recommend
Plain Bearings	Circulation, Splash, Ring Oiled, Drop Feed, Hand	
Anti-Friction Bearings	Grease Gun	
Bevel Gears	Circulation, Splash, Brush or Paddle	
Reduction Gear Sets	Circulation, Splash	
Main Bearings	Drop Feed	
	Force	
Other Bearings	Drop Feed or Force	
	Hand	
	Grease Cups, Gun	
Gears	Brush or Paddle	

STEAM HAMMERS

Part	Method of Application	What Type of Lubrication Do You Recommend
Steam Cylinders	Hydrostatic or Force Feed	
Ram Guides	Hand Oiled or Force Feed	

HAND SPEED FORGING PRESSES

Part	Method of Application	What Type of Lubrication Do You Recommend
Steam Cylinders	Hydrostatic or Force Feed	
Columns	Hand Oiled or Force Feed	

MILL DRIVES—ENGINE DRIVEN

Part	Method of Application	What Type of Lubrication Do You Recommend
Steam Cylinders	Force System	
	Hand System	
	Oil or Grease	
Journal Crank and Head	Force System	
	Hand System	
	Oil or Grease	
Eccentrics	Force System	
	Hand System	
	Oil or Grease	

SERVICE AND HYDRAULIC PUMPS

Part	Method of Application	What Type of Lubrication Do You Recommend
Steam Cylinders	Hand or Force	
Water Plungers	Brush or Swab	

GAS BLOWING ENGINES

Part	Method of Application	What Type of Lubrication Do You Recommend
Gas Cylinders	Force Feed	
Journals	Hand or Force Feed	
Eccentrics	Oil or Grease	
	Hand or Force Feed	

CHIPPING AIR HAMMERS

Part	Method of Application
Cylinders	Oil or Grease (If suspended in oil when idle)
Belting—Mill Drives and others	How kept in condition—Belt dressing or oil—How applied

MACHINE TOOLS

Part		
Bearings	Motors	
Gears	Belts	
Drives	Pulleys	

TURBINES

Method of Application	Lubricant Used?
Force System	
Type of Filtering Apparatus	

MOTOR GENERATOR SETS, ROTARY CONVERTERS

Method of Application	Lubricant Used?
Force System	
Ring Oilers	

MAIN DRIVE MOTORS

Method of Application	Lubricant Used?
Force System	
Ring Oilers	
Circulating System	

AUXILIARY MOTORS

Method of Application	Lubricant Used?
Ring Oiler	
Grease Cups	
Grease Gun	

*Steel Mill Lighting Problems**

By R. F. SANNER†

Discussion

Discussed by

W. H. Burr, Electrical Superintendent, Lukens Steel Company ,Coatesville, Pa.

Ward Harrison, Director of Illumination, National Lamp Works, Nela Park, Cleveland, Ohio.

Fred W. Acker, Assistant Chief Elec., Inland Steel Co., East Chicago, Ind.

F. H. Kittredge, Electrical Engineer, Illinois Steel Co., Joliet, Ill.

J. D. Donovan, Electrical and Mechanical Superintendent, Republic Steel Corp., Massillon, Ohio.

Frank Wiley, Elec. Engr., Wisconsin Steel Works, South Chicago, Ill.

J. J. Booth, Electrical Superintendent, National Tube Company, Gary, Ind.

R. F. Sanner, Assistant Elec. Engineer, Carnegie Steel Company, Duquesne, Pa.

James Farrington, Electrical Superintendent, Wheeling Steel Corp., Steubenville, Ohio.

W. H. Burr: A question came up within the last year in one of our departments upon which I hope some one present may be able to give me some information. In the chipping section, in order to get the illumination which it was claimed the men require, the foreman of that department insisted that a thousand watt lamp be placed below the crane runway in such position that it could be swung out directly above the work which was being handled. The question arose in the safety meeting as to the advisability of allowing such a practice to continue for the lamp was located only approximately two feet above the men's heads. It was purely a question as to the danger in case anything happened to the lamp while the men were working directly under it.

High Bay lighting, as Mr. Cramer has said, seems to be the thing which is uppermost in the minds of most of the steel engineers at the present time. It so happens that I have an installation of this kind in the chipping section of our plant in which the intensity corresponds exactly to what Mr. Sanner has given this morning. Where grinding is being done, we are using an installation in which we are getting 18-foot candles intensity.

Mr. Cramer also brought out the fact that the demand for better illumination in all of our plants is increasing each year. I am fully convinced, however, that if more attention was given to the cleaning of windows and providing adequate lighting during the day, that the cost of lamps and cost of power could be greatly reduced in most of our plants. The one thing which causes more contention I believe in our plant than any other in connection with the lighting is the responsibility of turning on and off the lamps in the various departments.

I would like ideas from some of those present as to who should be in charge and determine when lights should be turned on and off in the various departments.

Ward Harrison: Did you say those were 1000-watt lamps?

W. H. Burr: Yes.

Ward Harrison: Perhaps I can answer that question from the lamp man's point of view. Experience has shown that 100-, 200-, or 300-watt lamps are perfectly safe almost anywhere. However, a kilowatt is quite a lot of power to enclose in an ordinary lamp bulb; it would take no more than a drop of water on the bulb to make it crack, and then it is likely to explode rather violently. I don't think I would care to work with an unprotected 1000-watt lamp two feet above my head. A wire glass plate, or any heavy glass plate, or even just a wire mesh under the bulb would eliminate this danger, or if it is absolutely necessary, a bulb made of special hard glass can be obtained. The latter is rather expensive, however, and I think it is much more convenient to guard the bulb from below.

While I am here, I should like to compliment the author on his paper and to say that it is particularly gratifying to me to see from the steel men a paper dealing with problems of illumination from a distinctly constructive standpoint. The problem of illumination, like the poor, is always with us.

I saw statistics a few weeks ago which show that lost-time accidents are now occurring at the rate of 3,000,000 per year, which reminds me that from the standpoint of cost you pay for good lighting all the time, whether you have it or not, for if you don't have it you pay for it in the larger number of accidents which result when the light is inadequate.

Fred W. Acker: In regard to Mr. Burr's question about the billet chipping, a couple of years ago we had a similar situation. We had a bunch of billets that required very close inspection. The inspection department was always kicking about light. We tried everything. Finally, I put up five flood lights with non-glare lens and rearranged the overhead light, and to date I haven't heard anything about it. Keep the glare of the light out of the men's eyes.

W. H. Burr: We tried a similar application but had some trouble with the cords and as a result we have gone to the high bay lighting with the 22-foot

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* Paper presented at 26th Annual A. I. & S. E. E. Convention, June 1930, Buffalo, N. Y. Paper appeared in July 1930 issue Iron and Steel Engineer.

† Assistant Electrical Engineer, Carnegie Steel Company, Duquesne, Pa.

candle illumination, and are satisfied at the present time with this installation.

F. H. Kittredge: I think I can answer Mr. Burr's question to some extent in relation to the lighting of Inspection and Chipping yards.

At the Joliet plant, we used to attempt the overhead lighting of these locations at high altitudes, but on the account of numerous complaints from the inspectors and chippers, we were forced to lower these fixtures to a distance of 8 to 9 feet above the working plane, the supports for these fixtures are wooden standards, which are portable and can be moved so as to overcome glare and be located out of range of flying chips from the chippers. The 16-inch Wheeler Reflector is used with a 500-watt, gas filled lamp as the source of light. The portable stands are equipped with a 50 to 60-foot extension cord, which can be plugged in the main's at convenient locations.

These stands are also equipped with a generous base which makes them very stable and are seldom knocked over.

All chippers are required (as a safety rule) to wear goggles which protect their eyes from the flying particles of steel, but not for light glare as would be supposed with the fixtures located from 8 to 9 feet from the working plane.

W. H. Burr: What intensity do you think you have on the working surface?

F. H. Kittredge: I really do not know the exact foot candles, but from information which I have had from the chippers and inspectors, everything seems to be ideal, especially as the stands are portable and can be located to meet the intensity required.

J. D. Donovan: We have all had our troubles on billet chipping. We tried out the gib cranes and the low lights. Today we have done away with all of that. We feel we are getting somewhere between 25 and 28 candle power on our work at this time. We are doing it all overhead. We do not attach lights to buildings but run messengers the full length of the building and attach lights on same in order to absorb all shock and vibration. With the lights on the cranes we do away with the reflection when the crane is over the work. We have no trouble with these lights on account of using a double shock absorber to attach the lights on cranes. We are on that system now. We have had it three or four years and it seems to be giving more satisfaction than anything else we ever had. We have tried the standards and we have tried the crane effect. I believe our biggest trouble was we didn't realize how much light they really needed for that class of work. At least that was pretty much so in our case. They couldn't convince us they needed a little more light than what you need for real fine machine work. So in the last few years we have just simply taken and put all our lights up overhead in our buildings which are in the neighborhood of 50 feet high. Then we have equipped the cranes with lights and that has taken care of us in a very satisfactory way. I haven't heard anything from that angle for several years now.

Frank Wiley: The question was asked as to who should be held responsible for turning the lights on and off in the mills?

There is always a question as to who should be held responsible for turning the lights on at the proper time and turning them off at the proper time. Usually the mill operating force think that the motor inspector should be the responsible party, but I do not think so because he is not the man that is using them.

My thought is that the mill foreman is the man to see that the lights are turned on when needed and turned off when not needed. If you give a man a tool to work with and make him directly responsible for the return of the tool in good condition he will more than likely return it. While on the other hand if you give a man a tool to work with and hold someone else responsible for it, then nobody is responsible.

The lighting in a mill enters into the cost of production and the mill foreman, to a certain degree, is responsible for costs.

I would like to know what the practice is in other mills in regard to handling the lights.

J. J. Booth: Mr. Wiley and Mr. Burr seem to have a good deal of trouble on the question of turning off lights. It seems as though we cannot tie the responsibility on any one particular person to turn off lights. So far as we are concerned, we have tried several different schemes. We have tried the mill foreman; we have tried the watchman in the mill; we have tried the electrical foreman, and the motor inspector. To date, I think the best success we are able to get is to keep what you might say, continually after the mill foreman to get him to turn the lights off, and then through what we term a follow-up by the foreman in the electrical department, and by the watchman. The watchman, who comes under the chief of police in our particular plant, gives us full co-operation.

I have been very much interested in this paper by Mr. Sanner. There is one question I want to ask him in regard to the lighting of the open hearth, both on the charging floor and on the pouring side. Are those reflector glass?

R. F. Sanner: They are prismatic glass.

J. J. Booth: So far as we are concerned in our particular plant, we will keep all the lights off the crane that it is possible to keep off because they are so hard to maintain. On the other hand, if we are convinced by the operating department that they have to have lights on cranes and we have lights in three different departments on cranes, we will give in, but when we do it is reluctantly. If we listened to the operating force we would have lights on three different parts of every crane.

Relative to lights for chipping and inspection, we have tried Golden Glow and a number of other types of lights, where we tried to concentrate on the work on the bench. We have very close inspection. However, the best lighting we have found to date, and the thing which seems to be pleasing the inspectors more than anything else, is to set two posts, one post at each end of the inspector's table, over which the plate or sheets or billets as they might pass, and put a number of RLM reflectors about four or five feet above the plate. Our inspectors are able to check carefully, and also to detect any question of raw edges, ragged edges, or blisters.

Mr. Burr raised the question of cleaning windows. Gentlemen, I am not in the sales business, I am not

advertising any particular piece of equipment, but I merely suggest you try a pressure cleaning machine for cleaning windows. We have one in our own works, and I will give you a concrete statement of what some of the fellows say when we have cleaned the windows with a well known cleaning machine. Take the pattern shop, for instance. We cleaned the windows there shortly after we purchased the machine. I asked the men of the shop how they liked the work. "Well," they said, "I think we will have to get colored glasses, it is so light in the shop."

The same is true in the machine shop. We have about as large a machine shop as you ordinarily would find in a steel mill. I was talking to the superintendent of the shop relative to the windows and the light of the shop, and he was very much pleased.

I might say at this time that I even tried to clean a crane with it, but temporarily I have given it up. I am not down, but I am partially knocked out. I am going to try the crane again.

I am a sticker for 110-volt lighting in the mills.

There is one other proposition which may be of interest to you. We have from time to time had a good deal of trouble as to what is the proper method of supporting lights in a steel mill building. At the present time we are stringing messengers through the buildings, through the roof trusses. We put our lights on the messenger and run our feeeders parallel to the lights. If the mill foreman comes along and says that the lights are not in the right place, we will change any light in the mill in about fifteen minutes without any trouble.

So far as the control of your lighting circuits is concerned, we stick very closely to the panel box. The only suggestion I have relative to the panel box is, be sure you make your panel box large enough to accommodate the number of circuits. In our particular experience we find about the time we put in an eight-circuit panel box the mill foreman comes along and wants about three or four more circuits. So beat him to it and make the panel box of sufficient size to take care of all future needs.

The United States Steel Corporation has made quite an extensive test on lighting throughout mills. We have had the Westinghouse and General Electric Company go through our mills and check up on the lighting. I wish to state as far as our individual plant is concerned, that we were very highly congratulated on the light in the mills. We do think we have excellent lighting, but we have gotten wonderfully stepped on so far as our lighting in the offices is concerned. They recommended we tear it out and start all over again. I will say we are taking that under consideration at the present time.

I would like to ask if anybody is using the photoelectric cell for the control of lights?

Ward Harrison: I believe the photoelectric cell should more properly receive consideration for indoor use in turning lights on and off than for outdoor use, because outdoors one is more conscious of the time when light is required. As I remember it, the first development of the photoelectric cell in Schenectady was in connection with the lighting of school rooms, and school rooms usually have a load of about 1200 watts; what you would save in a year by turning lamps off at the proper moment would hardly compensate for the investment in the photoelectric cell. However, in a building using thirty 1000-watt lamps, if you are willing to put in a remote control system which will handle those lights from one switch, and connect your photoelectric cell up to that switch, then your lights will always be off when there is plenty of daylight and on when the daylight is inadequate. In an installation of this size, the cost of the cell is a relatively small matter.

James Farrington: In answer to the question of throwing off the lamps, I wish to say, that always is a very vital question. We have in a way combined the two systems. Our foreman has a designated time, depending upon the season. He throws out the lights. Then if the mill superintendent or his foreman wishes the lights put on, they throw the lights on. The mill is held responsible to throw the lights off.

All the yard lights are thrown off from the power house, who work on schedule, the same as the city operates theirs for street lights. We have just completed the lighting of a new strip mill, using only high bay lamps, with an intensity from 8 to 15, which does away with all individual lights. We can adjust our rolls, handle our guides, and move all of our machinery and equipment, and take care of the sheared sheets and coils, without the use of any individual light.

When we lighted the first building the management called me to account, saying I was spending too much money for light. After they saw the results obtained there was no question and I was allowed to continue to equip the rest of the buildings. They are all equipped with 750-watt lamps, four lamps to a circuit. The circuits are opened and closed in the regular way, and the circuit breakers are mounted in a bay that allows them to triple or quadruple the number of lights. There is a meter put on all the light circuits. The lighting is kept separately from the power, so the superintendent can get at the end of the month exactly what his lighting bill is costing him, as well as his power.

These units are all assembled on a Z frame bar, which takes the vibration off of the lamp. They are hung with a hook, which is detachable from the sockets, which are fused by a general plug. Then in case cleaning is required, for which we have tried to establish a schedule, the inspector takes two or three units with him, works off of a platform provided on the crane, takes down the dirty unit and replaces it with a clean one. He takes those to his shop and gives them the proper care and maintenance.

Fred W. Acker: In regard to cleaning the RLM Reflectors, in our plant we use a paste. No matter how dirty this reflector is, full of grease, oil, or anything else, if you will take this paste and rub it around inside with a dry rag, it brings it back to its natural state.

R. F. Sanner: In order to assure continuity of lighting service in the Upper Works, we have just recently connected all our lighting transformers to one 6600-volt feeder from the power house. This feeder is a three-phase cable which extends from the

power house to the north end of the Upper Works, looping through each of the lighting transformer substations. At present this is a radial feeder, but eventually we hope to extend this feeder to one of the 6600-volt switching stations which will provide an additional means for supplying power to this load. This will then enable work to be done on any section of the feeder, without interrupting the power supply to any of the lighting transformer substations.

Formerly the lighting transformers were connected to the most convenient power feeders, and of course, when for any reason, there was an outage on the feeder there was an interruption of the lighting service.

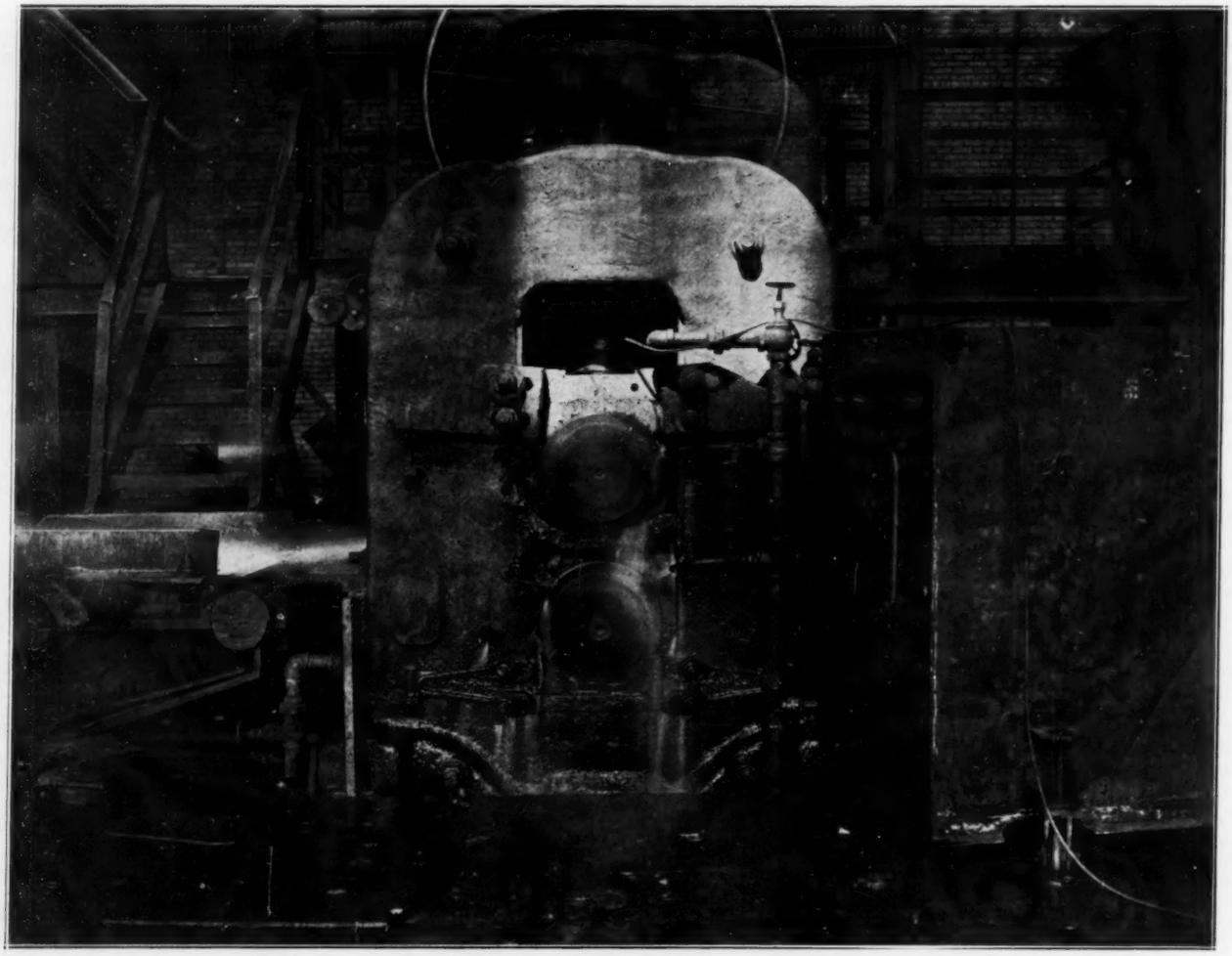


FIG. 1.

Measuring of Roll Pressures†

By FRANK H. BUHLMANN*

I shall briefly describe the apparatus which the Rollway Bearing Company has adopted for the measuring of roll pressures in order to facilitate the selection of bearings for service conditions as found in rolling mills as well as to gain a better understanding of such conditions. Cases of premature failure of bearings and rolls as a consequence of the material being stressed too highly can only be prevented if the pressures on the rolls are definitely known and this knowledge thus formulated as to guide the designer in his calculations. Theoretical considerations alone are not sufficient because on account of arbitrary assumptions which are necessary on account of the complexity of the problem, such solutions are only approximately correct, to say the least, and bear checking by the experimental method.

Several methods have been used to measure rolling pressures. By one method the deformation of the roll housing can be determined by means of strain meters and the load producing the strain deduced from it. Another method which has been used extensively is similar to some methods used in

† Presented at 26th Annual A. I. & S. E. E. Convention, June 1930, Buffalo, N. Y.

* Chief Engineer of the Rollway Bearing Company, Syracuse, N. Y.

measuring the hardness of materials in that it is based upon the penetration of one or several bodies into another body under the influence of the load. It has been called the Brinell method, since hardened balls are in compression between plates. The load is then determined by reproducing the impressions made by the balls on one of the plates in a testing machine. It is not very advantageous in that it interferes seriously with production in a mill if the plates are removed after each pass as they should be in order to give at least approximately correct results, or if they are left during several passes the final impressions on the plate are the sum of the impressions made by various passes which would make the result rather questionable. Also, the method of calibration on a testing machine can only give very approximate results.

A more satisfactory method was used as early as 1910 by Doctor Puppe of Dortmund, Germany, in determining rolling pressures and was described in a paper read by me before your Society during the Pittsburgh Convention in 1927. It is a method which has again been successfully applied in this country in recent years and consists of a hydraulic cylinder and piston placed between upper chock and screw-down, the pressure being transmitted by means of a liquid, usually glycerine, through a small tube to a pressure gauge. Although this apparatus eliminates some of the objections listed above in that it can be left in the mill without interference with production and can be calibrated more accurately, it still has some undesirable characteristics. One of these is the inertia of the pressure gauge element which is usually of the helical type consisting of a coiled metal tube, closed at one end, with the pen arm fastened to it. The pressure is admitted inside this tube and uncoils it thus turning the pen arm or indicator. When the load in the mill is applied suddenly, i.e. during a very short interval of time as may be the case in the rolling of certain materials, the inertia of this pressure element may delay its uncoiling as compared to the rate at which the pressure increases so that the maximum pressure would not be indicated at the time it occurs and if the load

FIG. 2.

is of short duration would not be indicated at all. In case of sudden load applications, it is also often necessary to use a damper with this type of instrument which would obviously aggravate described condition, this being even the purpose of the damper, protecting the instrument against sudden load applications.

These difficulties are eliminated by the apparatus which we have adopted, using the McCullum-Peters Electric Telemeter and Oscillograph with camera. The telemeter is an instrument in which pressure varies the resistance of refined carbon-pile rheostats, producing an unbalance in a Wheatstone bridge circuit that is exactly proportional to that pressure. This unbalance is recorded directly on a milliammeter or recorded by an oscillograph. Two carbon resistors are mounted opposed in each telemeter, thus cancelling temperature effects, and the resistors become two variable arms of the Wheatstone bridge, the fixed resistances being located in the panel board of the apparatus.

A solid heat-treated chrome vanadium steel plug to which three telemeter elements are attached is inserted between the upper chock and the screw-down of a mill stand, taking the place of the braker-block. This is shown in Figure 1, the plug being installed in a 2-High mill. The telemeter elements cannot be seen because they are protected by an outside case. When under load the plug is slightly deformed as would be the braker-block or the screw and other parts of the mill, all being made of elastic material. This slight deformation in the plug however, is sufficient to change the resistance in the carbon piles of the telemeters attached to it, thus producing an unbalance in the bridge circuit as described. Obviously the deformation and, therefore, also the obtained reading will only be directly proportional with the acting load within the elastic limit of the plug so that the latter has to be proportioned accordingly. Three elements are used in order to obtain an average reading, since the load is hardly concentric with and in direction of the plug axis. The telemeter readings can either be obtained individually or the telemeter can be connected in series which is the case in Figure 1, giving directly an average load reading. The wire connecting the measuring plug with the recording apparatus can readily be seen in the picture.

Figure 2 shows the recording instruments and connecting wire to the panel-board which is shown in the lower foreground. The panel-board contains the fixed arms of the Wheatstone bridge and the milliammeter connected across the bridge to measure the unbalance; it being the first instrument looking at the picture. There are three repetitions of the bridge circuit in this panel; i.e. three pressure plugs could be connected simultaneously. Back of the milliammeter in the panel is a voltmeter and a series rheostat by means of which voltage from a storage battery is maintained constant in the circuit. Control of the bridge voltage provides a wide range of sensitivity, as voltage and sensitivity, i.e. the deflection of the milliammeter needle are directly proportional for a given load. In this respect this apparatus is much more flexible than the others described before. For instance, if the pressure which is being measured is small which would ordinarily result in a small deflection of the milliammeter needle, the deflection can be increased by increasing the bridge voltage, thus increasing the accuracy of the readings. In addition a plug contact on the board provides a means of doubling the deflection without changing the voltage. There is also provided for each bridge circuit a slide wire rheostat for obtaining final balance of that circuit.

The equipment as described thus far, i.e. telemeter, pressure plug and panel board, is sufficient to make tests, the pressure being read on the millammeter after calibrating the apparatus in a testing

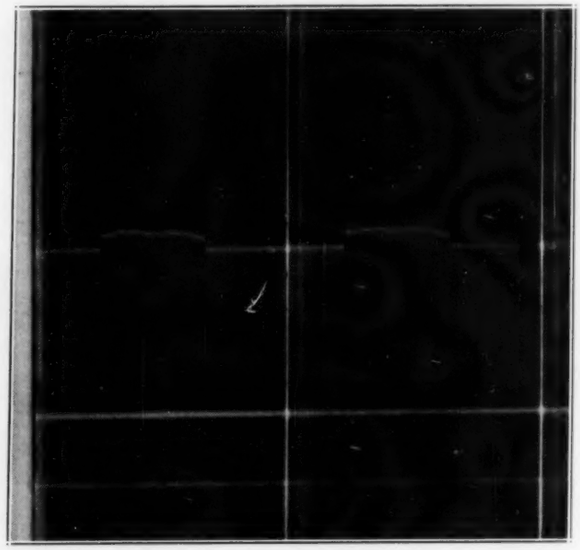


FIG. 3.

machine under known load conditions establishing a calibration curve which gives the pressure as a function of the milliammeter needle deflection for the voltage chosen for calibration. For any other voltage the pressure will vary proportionately.

To obtain permanent records and also in order to be able to record the rate of change of the pressure during the pass, the Oscillograph can be added to the equipment. The Oscillograph box is shown in Figure 2 on the table in the background. It has several moving elements, highly sensitive recording ammeters, each of which carries a small mirror reflecting a beam of light upon a moving film. For the purpose of bringing these Oscillograph elements into action, each respective bridge circuit has a double throw switch on the panel board. The Oscillograph is far more sensitive than commercial oscillographs on account of the small currents employed and the elements are so light that they can follow rapid changes in small current values, making readings practically instantaneous. Yet the apparatus is very rugged and no difficulties have been encountered in shipment or handling. The camera is easily detachable from the oscillograph box and can be loaded with 100 feet of photographic film or paper. It is also equipped with an internal film cutter and detachable reel box so that exposed part of the film can be cut and removed to a dark room at any time

during the test. The film is driven by a motor with variable speed reduction both of which can be seen on the table in Figure 2. On the right of the table the six volt storage battery can be seen which provides current for the circuits, oscillograph light and motor. The oscillograph is also equipped with a timing recorder which can be operated by several methods.

Figure 3 and 4 show test records obtained in the mill shown in Figure 1. These tests mere made in a continuous ten stand hot strip mill of the Republic Steel Corporation at Warren, Ohio, both the 2-High #5 stand shown in Figure 1 as well as one of the 4-High finishing stands were tested. Higher pressures than actually recorded were expected so that a two million pound maximum capacity plug was used. Since the actual pressures were considerably smaller, being in the neighborhood of 200,000 to 400,000 lbs, at the measured location (with few exceptions where the pressures were over 600,000 lbs.), the magnitude of deflection obtained by the oscillograph was comparatively small so that these records do not fully illustrate the possibilities of the apparatus. The reason is that the Oscillograph sensitivity cannot be doubled like the sensitivity of the milliammeter by means of the plug contact as discussed before. Actually a smaller pressure plug should have been used for these loads which would have increased the deflection of the oscillograph although satisfactory readings could be obtained on the ammeter on the panel board. Although the scale is not shown on the records of Figure 3 and 4, it can easily be determined from the calibration of the apparatus.

With further reference to the possible influence of the inertia of gauge elements upon the accuracy of readings as discussed before for hydraulic gauges, we observed in a test made with our apparatus in a commercial bar mill where pressures were applied suddenly and during a short interval of time that the inertia of the fine milliammeter needle was sufficient to retard the needle and give a lower reading than the oscillograph. Of course, when rolling strip, as illustrated by the test shown on these figures where a pass may last fifteen to twenty seconds, there is sufficient time for the needle to follow the load.

In addition to its high sensitivity and unusual flexibility it can also be seen from these figures that by making the connecting wire between plug and recording instruments long enough, the instruments can be set up at any desirable distance from the place at which the test is actually made, thus eliminating interference with other phases of work in the mill. This feature could obviously not be obtained without difficulty with the other measuring methods used. Again the recording instruments can be connected or disconnected at will without it being necessary to remove the plug from the mill. In fact during the test shown in Figure 1, the recording instruments were removed for the night after testing during the

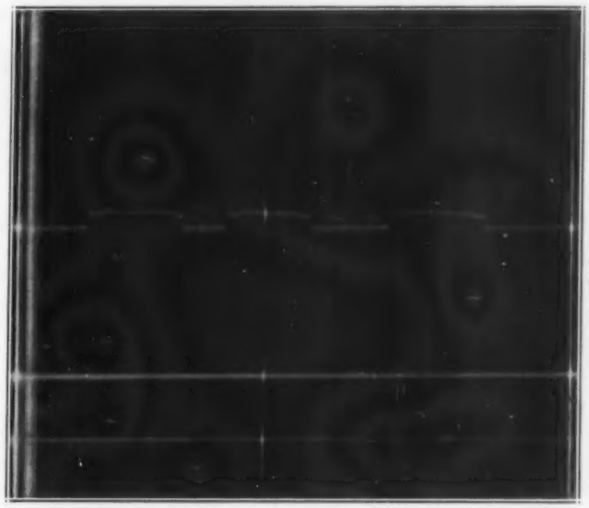


FIG. 4.

day and the plug was left in the mill just like an ordinary braker-block, the instruments being again connected and tests resumed the following day. After obtaining further readings on a different gauge steel the plug was then installed in one of the 4-High finishing stands.

A wide range of pressures can be measured with comparatively a small number of plugs. So far three plugs have been found sufficient for a range of loads up to 2,000,000 lbs., one plug having a capacity up to 150,000 lbs., the following plug from 50,000 to 500,000 lbs.,and the largest plug from 200,000 to 2,000,000 lbs. The plugs have been designed as small as possible so that they can be used in as many mills as possible, this depending entirely upon the available space between chock and screwdown which varies with different makes of mills. Before the plugs were made we secured this information from various designers.

The results obtained so far with this apparatus have been very encouraging and should prove of great help in making intelligent bearing recommendations. At the same time the information should be very valuable to the mill industry at large as it is a contribution toward a better understanding of the forces and factors brought into play during the rolling operation and when collected from various sources and reduced to fundamentals should prove of great value to both operating and designing engineers.

The Rollway Bearing Company has made a number of successful bearing applications to rolling mills, both 2-High and 4-High and with the apparatus described has materially increased the service which it is pleased to offer to the industry.

Economical Control of Purchased Electrical Power in the Industrial Plant

By R. F. GALE*

The economical control of the purchased power for the average industrial plant, is in most cases a very difficult problem. We at Midvale feel that we are particularly fortunate in having the necessary apparatus to control a considerable fluctuation of load, in that we use steam generating apparatus in conjunction with the purchased power. In other words an industrial plant which provides for increased electrical load by purchasing power and keeps the direct generation in useable form, finds itself in the enviable position of being able to control the purchased power to a nicety.

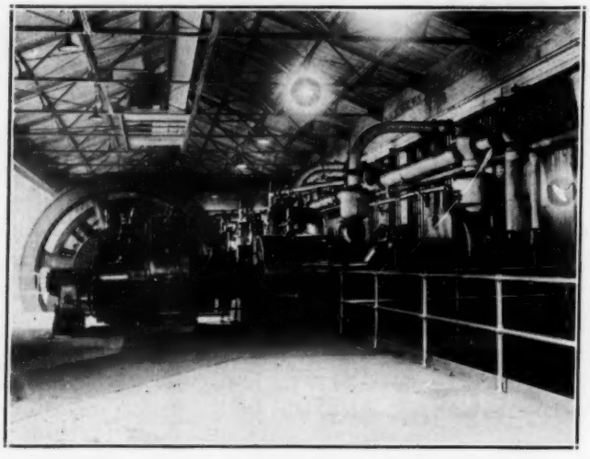


FIG. 1.

Fig. 1. General view of Power House Interior.

FIG. 2.

Fig. 2. General view of 250 Volt D.C. Switchboard.

* Plant Engineer, The Midvale Co., Philadelphia, Pa.

Fig. 3. Indicates the electrical hookup and diagramatically illustrates the flow of white and black fuel. You will notice that there are two sources of power, (White Coal) coming over two feeders from the P. E. Co., approximately 5,000 KW capacity each, one to No. 1 Sub Station, and one to No. 2 Sub Station, about 2,000 feet apart. The second source of power (Black Coal) comes from the Boiler House, which is maintained and operated for

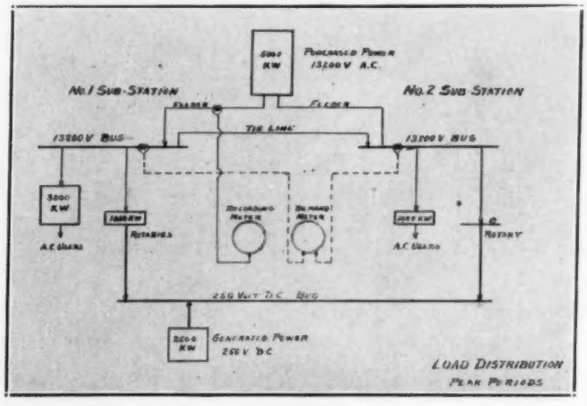


FIG. 3.

direct steam driven applications. A small amount of this, is available for direct steam generation, 250 Volts D.C. in the original Power House. The sub station and power house busses are interconnected with tie lines both A.C. and D.C. With this arrangement, part load can be readily transferred from the coal pile to the Public Utility and vice versa at will.

With these preliminaries over, now for the subject matter proper. This covers the manipulation of part of the electrical load involving no curtailment or interference with normal production throughout the plant. The loads are handled as they come, and when they come, literally playing ball with the Kilowatts.

Normally the purchased power flows into the plant through the feeder from the Public Utility at 13,200 Volts, into No. 1 Sub Station, to which a recording meter is connected and mounted on the switchboard in the Power House, in plain view of the switchboard attendant. Should it become necessary to use the other feeder (spare) to No. 2 Sub Station, the switchboard attendant or first engineer of the Power House immediately finds himself in difficulties as to the magnitude of the purchased power at any time.

A "Duplex" demand meter is being installed on the D.C. switchboard in place of the recording meter above referred to, which will register the total peak of purchased power supplied over either or both feeders at all times. The connections of this meter are shown on the diagram. As you will see this meter operates from the instrument transformers

located at the two Sub Stations and used in connection with the Public Utilities KWH meters. It is the readings of this instrument which will constitute the base for billing the KW demand.

As an illustration of the economy obtained by this method the unit fuel cost per KWH for February, was roughly eight and one-half (8½) mills. If no control had been attempted and all power purchased, the cost per KWH would have been one cent.

FIG. 4.

Fig. 4. Shows the recording meter as it is mounted on the original Power House 250 Volt D.C. Switchboard, with the Engineer watching the load conditions.

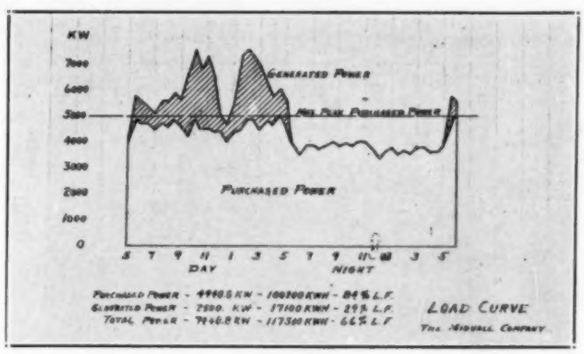


FIG. 5.

Fig. 5. Indicates a typical twenty-four (24) hour load. The top or shaded section indicates power generated from steam (Black Coal). The lower portion or unshaded section indicates the purchased power (White Coal).

Please note that the day load peak (7,500 KW) is approximately 3,500 KW greater than the night load peak (4,000 KW).

The load factors for this day were:

84%—Purchased Power.
66%—Purchased and made Power.

Due to curtailment of operations over week ends and holidays, these figures reduce themselves to approximately 68% and 53% respectively. If no attempt was made to control the load or were there no direct steam generation available, the local factor would drop to 53%.

By studying these load factors and the ratio of made power to purchased power, a very intelligent guess can be made and a KW value given the engineer the first of each month. This KW constitutes a set peak or dead line and was 5,000 KW during the month under discussion.

The fluctuations are caused by a six (6) ton Heroult Electric Furnace, using 2,500 KW when melting down. This is 50% of the set peak. With the furnace operating, D.C. is transferred from Rotary Converters to steam Turbine, i.e., from white to black coal, so as to maintain the 5,000 KW set peak and maximum load factor which is so essential on all Purchased Power contracts.

This transfer is done by the First Engineer, who also acts as the switchboard attendant in the steam generating plant, known as the Power House. He is in direct telephone communication with sub stations, Electric Furnace, and Boiler Plant.

Fig. 4. Shows the operator, observing total purchased electric load by watching it register on the recording meter.

Besides the insurance or standby feature, a good load factor on the purchased power was obtained economically even with extravagant steam engines, and we found it good business to purchase a new more economical prime mover.

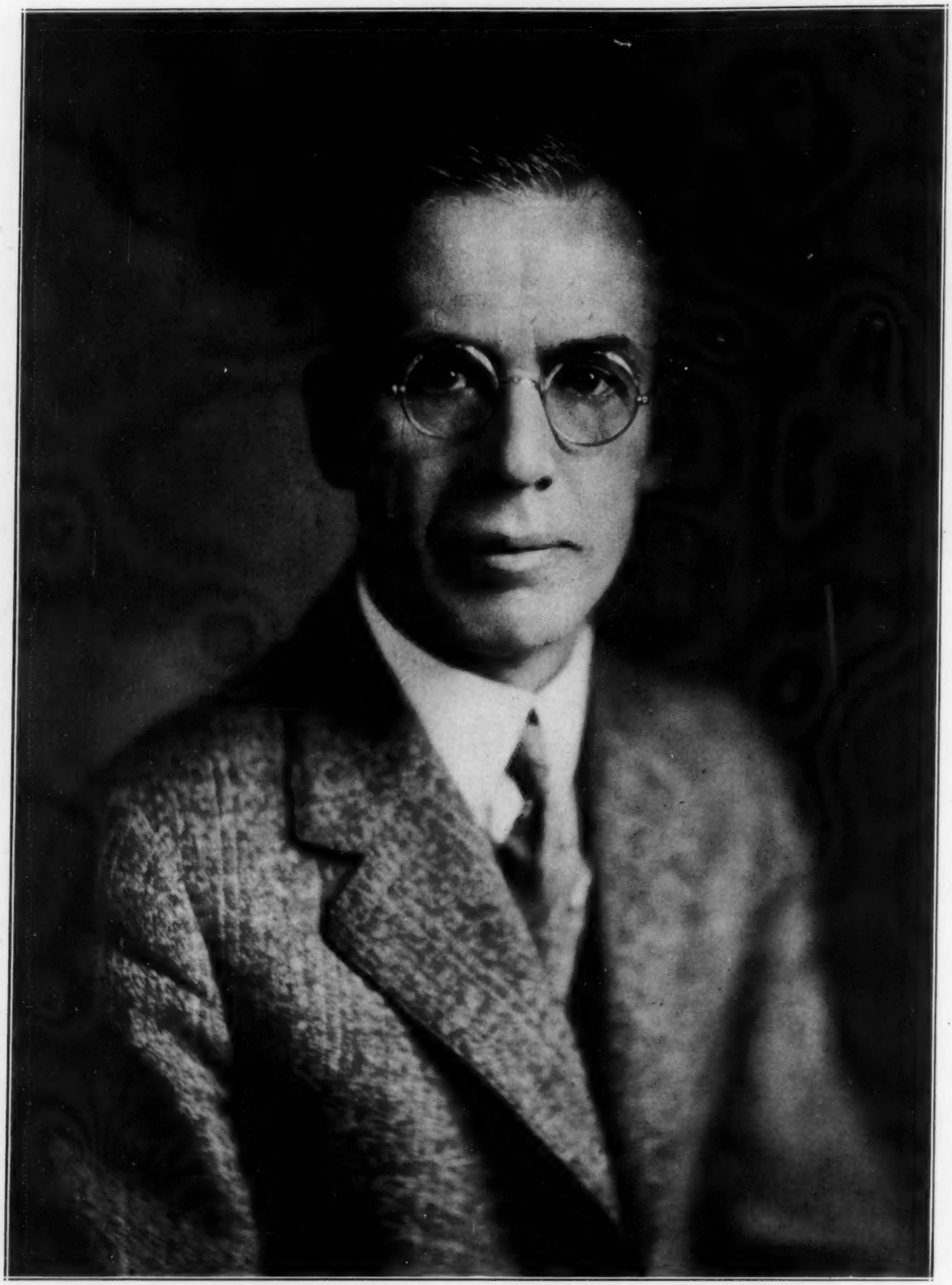
The result was a saving of 50% in steam consumption to hold the peak and 100% more KW Hours from Waste Heat Boiler steam, which has to be used to prevent the safety valves opening. In cold weather this steam is used for shop heating, but in the summer months it makes KW hours.

Where all power is purchased it may prove economical to install generating apparatus if a Boiler House has to be maintained for other reasons.

It has been said that the size of such a proposed unit should be equal to the difference between the day and night loads, but the speaker feels that one-half to two-thirds this difference is a more representative value.

If the calculations indicate a stand off the additional features of insurance against failure of power, the character and importance of certain loads, limited power available while working on the purchased power equipment when crippled or down for repairs, at least preventing the interferring in carrying a heat, air, oil, or drainage pumps, Boiler House Auxiliaries, etc. will certainly encourage and warrant the expenditure. Even a very small steam driven unit may prove itself extremely valuable under certain conditions.

I want to take this opportunity to express my appreciation for the assistance of Mr. J. McTamney and Mr. H. Cosdon, Mr. H. Lloyd and Mr. R. Seltzer, in preparing this paper. These gentlemen are with us tonight and will be very glad to enter into the discussion.



E. N. McKelvey, General Manager, Steubenville Works, Wheeling Steel Corporation, who will act as host to the members and guests of the Association of Iron and Steel Electrical Engineers when they visit the Steubenville Works on December 3rd, 1930.

Steubenville Works, Wheeling Steel Corporation

A. I. & S. E. E. to Inspect Steubenville Works, Wheeling Steel Corporation

When members of the Association of Iron and Steel Electrical Engineers make their pilgrimage to Steubenville, Ohio, on December 3rd, 1930, to visit the Steubenville Works of the Wheeling Steel Corporation, they will see the largest continuous Strip-Sheet-Plate Mill in the world in operation.

This mill consists of a Universal Slabbing mill, two 2-High and nine 4-High finishing mills which possess all the features of continuous mill construction and operation perfected during recent years with others that are of last moment perfection and exclusiveness.

Some idea of the innovation in steel rolling practice that has been perfected by means of this new "Strip-Sheet-Plate Mill' may be gained from the fact that it provides continuous and uninterrupted production from the Open Hearth furnace to the final finishing departments and is probably the only mill rolling direct from the ingot.

It makes possible utilization of the original heat of the steel as the ingot travels approximately 1,000 feet, through slabbing mill and finishing mills until in the form of plate, sheet or strip in various dimensions and thicknesses it is delivered flat or coiled to storage or shipping warehouses.

To follow steel through its course on this new mill is to give one's imagination a severe test since it seems quite beyond human means to manipulate the great rolls and tables with scarcely any evidence of manual control. The slabbing mill is connected in direct line with the finishing mill, allowing continuous movement of slabs through the eleven stands of rolls. Reheating furnaces are provided between slabbing mill and first stand of finishing mills into which slabs may be passed while hot when it is so desired.

From the vantage point of a steel balcony one may witness the continuous conversion of the ingots

into slabs, which, going through the first of the 2-High finishing mills receive in a matter of moments a reduction of as much as 50 per cent in thickness. Subsequently they emerge from the nine stands of 4-High mills in the form of strip at the rate of 1,200 feet a minute. Some of these strips may be from 300 to 500 feet in length.

As these long strips are finished they pass through rotary flying shears which accurately cut them to lengths, and then pass on over run-out tables to mechanical pilers and cooling beds. The operation from the beginning to end is remarkably rapid. Without by-passing the shears, shearing can be omitted by the push of a button and the strip sent rapidly into coilers which deliver it in one continuous coil, the length depending upon the size of the original slab and finished gauge and width required. The uniformity of the product of the new mill is said to surpass anything that has been heretofore achieved by earlier processes.

J. A. Farrington, Electrical Superintendent, Steubenville Works of the Wheeling Steel Corporation.

Of course the Association of Iron and Steel Electrical Engineers will be particularly interested in the Electrical, Mechanical, Lubrication, and Combustion equipment necessary to the operation of a mill of such magnitude. During the construction of the mill it was necessary not only to construct and equip what is probably the largest and most modern steel mill power house, but a new electric sub-station was also required for the city of Steubenville as well, before a wheel in the new plant could be turned. A part of the preliminary electrical work for the mill was the running of 66,000 volt power lines to this new sub-station from Power, W. Va., where a large electric generating plant is located.

The mill is electrically operated throughout and the auxiliary equipment required for the production and transmission of power is naturally extensive.

Seven motor generators with combined capacity of nearly 15,000 kilowatts, and motors ranging from 7,500 to a fractional horsepower are housed in the motor room of the mill building. This motor room is not only a thing of wonder but a masterpiece of industrial architecture. Lined with light colored, glazed brick, the high walls support a special type of roof that permits natural illumination. The interiors of all buildings are almost as light as day.

Cleanliness and constant temperature being two primary requisites of motor rooms, these are insured by air washing equipment beneath the room which supplies cool, washed air at the rate of 500,000 cubic feet a minute. A 30,000,000 gallon water pump at the river supplies water for this purpose as well as for other requirements.

This producing unit which no doubt surpasses anything of its kind ever attempted before, gives to the Wheeling Steel Corporation an unique and efficient link in its production of steel "From Mine to Market." On this mill may be rolled many kinds of stock, coiled strip or flat strip steel, skelp for tube mill use and plates of all kinds. One of its advantages is its adaptability to almost any kind of hot rolling problem.

On December 3rd, as guests of the Wheeling Steel Corporation, members of the Association of Iron and Steel Electrical Engineers will be conducted through the new mill building and the adjacent motor generating room. They will then see at first hand the operation of this equipment. After the sightseeing trip the engineers will attend a luncheon given by officials of the Wheeling Steel Corporation and will hear a technical discussion of the mechanical, electrical combustion and lubrication devices in use on the mill.

13 Tables 18 Tests of Rolling Pressures and Power Requirements

FOR

ROLLING STEEL SHAPES

From Tests Conducted By Dr. J. Puppe, Germany

Translated and Compiled from the German Text Published by Dr. Ing. J. Puppe. Dusseldorf, Germany, in 1913 Under the Auspices of Vereins Deutcher Eisenhüttenleute.

By F. Waldorf, Pittsburgh, Pa.

Price $2.00 Per Copy

Iron & Steel Engineer—1010 Empire Building, Pittsburgh, Pa.

HENRY A. LEWIS

Harry A. Lewis, age 65 years, an active member of the Association of Iron and Steel Electrical Engineers died Friday night, October 3, 1930.

Mr. Lewis was one of the most active members and enjoyed the confidence and esteem of the electrical profession at large.

He was considered, in the Iron and Steel Industry, an electrical genius and has to his credit about 50 patents covering applications to the Iron and Steel Industry.

Mr. Lewis had been associated as chief electrical engineer with the Alan Wood Steel Company since 1902 and was considered one of the firm's most valued employees.

One of Mr. Lewis' earliest positions was with the Pennsylvania Railroad Company, later with the Phoenix Iron Company and then with the Alan Wood Steel Company.

The Association wishes to extend to the relatives and friends of Mr. Lewis their sincerest and deepest sympathy.

Items of Interest

PERSONNEL CHANGES

The American Rolling Mill Company has organized a new division of its sales forces—the Railroad Division—which will combine the handling of wrought steel wheels, and iron and steel sheets and various other products. The headquarters will be in the company's general offices in Middletown, Ohio.

C. G. Bacon will be director of Wheel Research. For many years, he has been recognized as an outstanding authority on wheel problems.

In St. Louis, F. E. Finley has been made district manager. He will also continue to handle Sheffield business.

Ernest Baxter has been made manager of the Chicago district. He will continue, also, in his present capacity as Vice President of the Sheffield Steel Corporation, in charge of their railroad sales.

Three district offices have already been established. W. B. Quail will manage the New York Office, assisted by W. A. Dibblee and E. C. Bray. The latter will be located in the company's Philadelphia Office.

Logan T. Johnston has been made manager of Armco's Railroad Division, and H. M. Arrick, assistant manager. Both men have had practical experience in the railroad field, as well as in the marketing of iron and steel products. Mr. Johnston was formerly with the Standard Steel Car Company of Pittsburgh, and later assistant to the Vice President in charge of the commercial activities of Armco's Forged Steel Wheel Division. Mr. Arrick, before joining the Armco sales department three years ago, was associated with the operating department of the Pennsylvania Railroad.

R. G. Adair, staff supervisor of safety and training, American Rolling Mill Company, Middletown, Ohio, has been appointed assistant to the works manager of its Butler, Pa., plant. He has been with the American Rolling Mill Company organization for almost 15 years.

WITH THE MANUFACTURERS

The Ivanhoe Division of the Miller Company, Meriden, Conn., have just issued a new complete catalogue, No. 900, covering their line of industry, porcelain enamel, aluminum reflectors and fittings and industrial illumination.

This catalogue is a very complete book on Industrial Lighting equipment. It contains 60 pages of information which is of interest to all users of lighting material.

The Ivanhoe Division of the Miller Company will be glad to forward a copy upon request.

The Whiting Corporation, located at Harvey, Ill., has just issued a handbook of crane information. This handbook is the result of a number of years of experience in crane manufacturing and represents the efforts of the Engineering, Service and Developing Departments.

This handbook should, undoubtedly, be of value to executives and engineers.

Youngstown Sheet and Tube Company's new $3,000,000 electric weld pipe mill began commercial production recently.

The first production will be 18-inch pipe for a southwestern gas line.

The Republic Steel Corporation has received an order from the Biggs Boiler Works, Akron, Ohio,

for Toncan iron plates to provide one mile of water pipe for the city of Detroit. The pipe will be produced by the Biggs company by the electric welded process. This is the first pipe made of Republic's Toncan iron, a rust resisting material, to be used in Detroit.

The pipe will be fabricated in 32-inch lengths without circumferential seams. The field joints will be made with Dresser couplings. The plates from which the pipe will be made will be ½-inch in thickness, 114¾ inches wide by 383⅝ inches long, requiring one such plant to make a standard 32-inch section. The pipe will be hot tested, preheated and vertically hot dipped. On account of the absence of seams of any character and its extremely smooth interior, the pipe will afford a maximum carrying capacity.

The Cleveland District Section of the A. I. & S. E. E. opened up the fall program with an inspection trip to the American Steel and Wire Company at Cleveland, Ohio, on Tuesday, October 28th. About 400 attended the trip. In the evening the Electric Controller and Manufacturing Company sponsored the presentation of a moving picture of Commander Byrd's Expedition to the South Pole.

FLEXARC PIPE LINE SPECIAL

A new 600-ampere, FlexArc, single-operator, engine-driven welder for pipe line welding was recently placed on the market by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. The demand for higher speed in welding gas and oil pipe line joints in the field has led to the development of this special welder for use with high speed, high current, large size, coated electrodes using high voltage arcs. While the machine is designed primarily for use with such electrodes, the application of the FlexArc principle permits equally good operating characteristics and arc stability on the low current ranges with small electrodes. The machine is particularly adapted to rough and severe field service where sustained loads and high currents are required over long periods.

This new welding unit provides welding currents up to 750 amperes for every job encountered by the pipe line welding operators. The welding generator is the variable voltage constant current type operating at 1450 rpm. The new Westinghouse Flexactor is incorporated in the welding circuit, thus eliminating current surges at the time of striking the arc and while welding.

The main generator frame fits directly into the engine flywheel housing, making it possible to use a single bearing flexibly-coupled generator. An oversize exciter is overhung from the main generator bracket for separately exciting the welding generator shunt field and for furnishing auxiliary power. Separate excitation greatly increases the efficiency and simplifies welding current control. The generator control consisting of a single dial rheostat, ammeter and voltmeter, are all mounted on rear panel of set with a protective cover.

The driving power consists of a six cylinder gasoline engine with an S.A.E. rating of 51.2 and 83 brake horsepower at 1450 rpm. This horsepower rating has been selected by the manufacturer to provide sustained power and long life. The welding unit is equipped with a 25-gallon gas tank, Pierce governor, Eisemann magneto, large air cleaner, oil filter and protective radiator guard.

The complete unit is mounted on common 8" welded channels and equipped with a sheet metal canopy, having removable sides and extending full length of the set, providing weatherproof protection to the complete machine. The overall dimensions of the stationary unit are 121"x34"x72" with an approximate net weight of 5000 pounds.

AN IMPROVED SPOT WELDING MACHINE

A quick-break contactor and adjustable pressure are two unusual features incorporated in the new AmerTran B-5 spot-welding machine which has just been announced by the American Transformer Company, of Newark, N. J. The former, a semi-automatic device which opens the primary circuit at will, permits the weld to freeze under pressure and prevents arcing at the electrodes. Because the pressure is adjustable for various types of work and is applied by a heavy spring rather than the operator, the machine may be used for welding copper and brass, resistance soldering, and applications requiring heavy pressure.

This is a bench-type unit mounted in a compact sheet-steel case requiring a space of only 12 by 14 inches. It stands 28 inches high and has two electrodes which protrude 15 inches from the front of the case. The device operates from a standard 220-volt, 50/60 cycle circuit and is available in three sizes, 5, 7½ and 10 kva. Standard equipment includes a foot-pedal control and a six-point primary switch for adjusting the welding current to the value needed for the particular job.

Various electrodes are available, the type supplied depending upon the character of the work. In all cases the space between the points is adjustable, and, where the welder is to be used continuously water-cooled electrodes are provided. The transformer employed is of the high-efficiency, short-coupled type; that is, the secondary leads have been made as short as possible to reduce heat losses to an absolute minimum.

The machine is capable of welding two sheets of steel of 3/16" thickness or less, or two sheets of copper or brass of 1/16" thickness—¼" spot weld in each case.

THREE POLE MAGNET FOR HANDLING SINGLE RAILS

A new type of lifting magnet has been developed to meet a situation common to most Railroads.

It is the general practice (at least on double track lines) to distribute rail along the right of way and follow up with a maintenance train which delivers cinder or stone, ties, fittings and lastly lifts the rail into position on the right of way.

The little Magnet can lift a 30-foot long rail weighing 130 lbs. per yard and it will not only lift such a rail or one longer or lighter by any point it touches, but it straightens itself out along the rail, so requires no attendant. The magnet weighs 935 pounds and takes about 1.5 K.W., D.C. Current to operate.

It is calculated to save a great deal of time and labor over the old sling chain methods.

It is made by The Ohio Electric Manufacturing Company, of Cleveland, Ohio.

A NEW MAGNETIC SEPARATOR PULLEY

Simple construction, better wearing qualities are features of the new type "W" magnetic separator pulley which is announced by Cutler-Hammer, Inc.

The new pulley has only three major parts—a machined cast steel spool, the magnet coils and a coil shield—with the necessary insulation. The magnet coils are wound on the steel spools and vacuum impregnated to make them moisture proof. The coil shield is then welded to the spool so that it completely encloses the coils. This coil shield is of Allegheny metal which provides a tough, long wearing, non-magnetic pulley surface.

The commutating mechanism, which conducts the current to the magnet coils, is mounted on one end of the pulley shaft. Heavy brass collector rings and carbon brushes assure good contact at all times. A dust-proof cover protects the commutating mechanism from dust and other flying particles and protects operators from accidental contact with live parts.

These new magnetic separator pulleys are made in 12 inch diameter size and in six lengths, for belt widths varying from 12 to 30 inches.

Allis-Chalmers Manufacturing Company, Milwaukee announces the receipt of order from West Virginia Hydro Electric Company, a subsidiary of the Union Carbide and Carbon Corporation, covering ten (10) large power transformers amounting to approximately $500,000. This is the second order recently received by Allis-Chalmers from this company. The previous order covering two welded steel surface condensers for use with 30000 KVA Steam Turbines.

NATIONAL CARBON COMPANY ENTERS THE FIELD OF LUBRICATION

Beginning November 1, 1930 the entire line of "Gredag" Lubricants manufactured by the Acheson Graphite Corporation a Unit of the Union Carbide and Carbon Corporation will be distributed and sold by the Carbon Sales Division of National Carbon Company, Inc., with headquarters at Cleveland, Ohio. The Carbon Sales Division of National Carbon Company has been active for many years in the sales and distribution of carbon, graphite and metal graphite brushes, illuminating carbons, welding carbons and numerous carbon specialties of importance to many industries. The addition of Gredag to the products of the Carbon Sales Division is considered a most logical step by National Carbon Company because this division of the company is in continuous contact with industrial plants and distributors of industrial products throughout the country. As is the case with its industrial carbon products, sales and technical service on all Gredag lubricants will be available at the Branch Offices and Service Plants of the Carbon Sales Division located in New York City, Pittsburgh, Birmingham, Chicago and San Francisco.

NEW INDICATING PYROMETER CONTROLLER

The new Brown Model 801 Indicating Pyrometer Controller can be supplied as an automatic control pyrometer, resistance thermometer, tachometer, or CO_2 meter.

Outstanding advantages claimed of this instrument are:

1. Reading observed directly on 6" scale.
2. Index on scale for setting to exact control point.
3. Control point instantly and easily adjustable.
4. All wiring terminals and motor enclosed. No danger when used in the presence of explosive or inflammable gases.
5. Mercury switches up to 30 amperes capacity, eliminating the necessity of relay equipment. Make and break occurs in sealed glass tube. No danger of spark causing explosion.
6. Suitable for "on and off" or "three position" control through switches, valves, dampers, etc.
7. Available with patented safety device which opens furnace circuit if thermocouple or wiring fails, preventing burning out furnace.
8. High internal resistance, insuring accuracy.
9. Automatic internal compensation eliminating cold junction errors when instrument is supplied as a pyrometer.
10. Simplicity and ruggedness insures minimum of attention.

The General Electric Company has announced a new grease for ball and roller bearing motors.

The grease embodies all necessary qualities for the proper lubrication of ball and roller bearings and is used in General Electric factories for the initial lubrication of all general purpose motors using these types of bearings. This lubricant is being successfully used on ball bearing application with speeds as high as 25,000 r.p.m. and temperature exposures from —25 degrees to 250 degrees F. However, its use is recommended only for the lubrication of motor bearings where the motors were originally grease lubricated.

Some of the advantages claimed for the new lubricant are:

1. High grade materials are selected for its compounding.
2. It maintains an operating consistency under severe conditions and over as wide a temperature range as will be encountered in service.
3. It allows complete ball and roller motion.
4. There is very little tendency to gum-cake or separate.
5. It contains no free acid or water and will not turn rancid.
6. It has unusual film strength, enabling it to stand severe thrusts and heavy bearing loads.

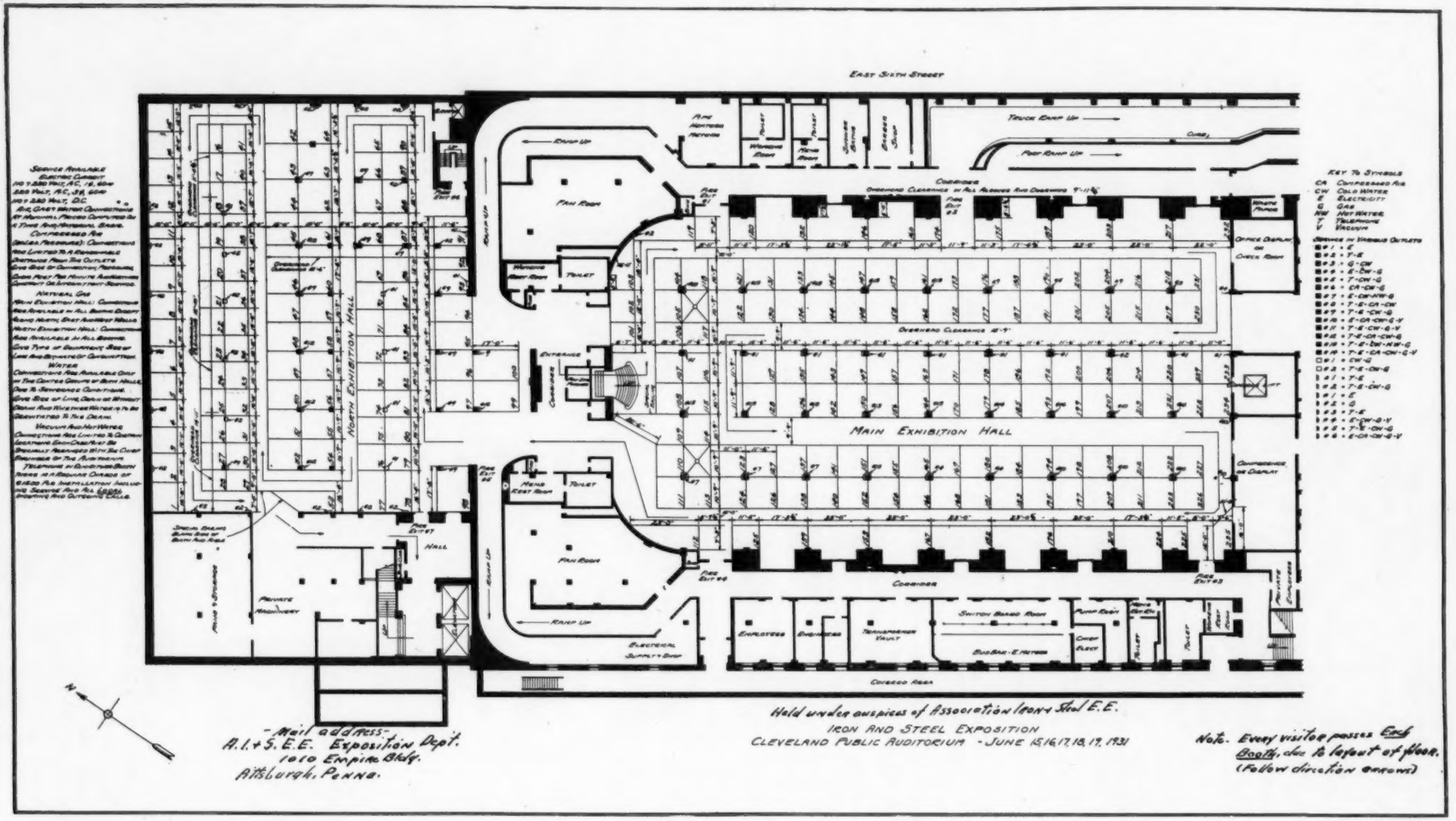
OBITUARY

A. H. Beale, president of the A. M. Byers Company died suddenly in Chicago, Tuesday, October 28th, 1930. Mr. Beale had been a prominent figure in the Steel Industry. For the last five years he had been president of the A. M. Byers Company and previously had been associated with the American Sheet and Tin Plate Company, Eastern Steel Company, Lebanon Iron Company and the Steel and Tube Company of America.

IRON AND STEEL EXPOSITION

CLEVELAND, O., JUNE 15-16-17-18-19, 1931

THE FIFTY MILLION DOLLAR MARKET FOR STEEL MILL EQUIPMENT



Floor plan of the Iron and Steel Exposition held under the auspices of the Electrical, Mechanical, Combustion, Lubrication and Safety Engineering Divisions of the Association of Iron and Steel Electrical Engineers, Cleveland, Ohio, June 15-19, 1931.

You will note that the arrangements of booths are such that every visitor will be required to pass each and every booth in the entire Exposition. To our knowledge this is the first time that any Industrial Exposition has been laid out along these lines.

Association of Iron and Steel Electrical Engineers

ELECTRIC OVERHEAD TRAVELING CRANE SPECIFICATIONS*

By GENERAL CRANE COMMITTEE
S. S. WALES, CHAIRMAN

1. Explanation

The body of this Specification is intended to cover all types of cranes 5 tons or over for mill service in general, and regarding safety features, but it is obviously impossible to include all details. The Special Information sheets to be filled out by the purchaser, are intended to adapt this Specification to all special requirements and conditions, which may from time to time present themselves, in the various plants, where cranes are used. All cranes for special service, such as soaking pits, strippers, ore bridges, gantry, etc., shall so far as possible, comply with this specification. Copies will be furnished to manufacturers for reference but will not necessarily be issued with each request for quotations. This specification will be made a part of the specific information furnished Bidder by Purchaser, and Order or Contract stating special features, sizes, etc., of cranes to be purchased.

Where features are specified to be AS REQUIRED, it is understood that the requirements covering such features are to be given in the specific information furnished Bidder by Purchaser. Where such information is not given or if this Specification offers an option, Contractor shall furnish material according to his judgment. Features not covered by this specification, or the specific information furnished Bidder by Purchaser, shall be in accordance with Contractor's standard or with what is known as good practice among Crane Manufacturers.

2. Specifications

This Specification shall be known as the Association of Iron and Steel Electrical Engineers E. O. T. Crane Specification. It shall be referred to in all contracts as such and shall form part of such contracts, when so stated, whether attached to same or not. Builder's Specification shall be known as Contractor's Specification. These specifications shall take precedence over contractor's specifications and shall be strictly adhered to, and no other specifications or understandings will be considered unless agreed to in writing.

Sheets issued by different works stating sizes, special features, requirements, etc., shall be known as PURCHASER'S INFORMATION SHEETS. Where the requirements of these Information Sheets differ from Specification, the former shall take precedence.

Sheets to be filled in by Bidder showing specific data in regard to apparatus he proposes to furnish, shall be known as CONTRACTOR'S INFORMATION SHEETS.

Where Contract covers a number of cranes, this Specification shall apply to each and every one.

In addition to Specifications furnished with proposition, Contractor shall furnish two (2) copies of his specification for the Work's file.

3. Propositions

Bidder shall submit his Specification in triplicate and return three (3) copies of Purchaser's Information Sheets and Agreement signed together with three (3) copies of Contractor's Information Sheets giving the required data in duplicate in the two columns, otherwise bids will not be considered. No alternative propositions will be considered unless accompanied by a proposition in strict accordance with these Crane Specifications. Additional blank Contractor's Information Sheets will be furnished on request to Bidder desiring to submit such alternative propositions.

Bidder shall also submit with his proposition such description, prints, etc., as shall be necessary to give full understanding of the general construction and special features of all apparatus included in his proposition, also prints showing general dimensions.

4. Changes

Purchaser reserves the right to make such changes in Specification or specific information as may be necessary after Contract is signed.

Any difference in cost resulting from such changes shall be agreed upon before work is begun on same.

5. Delivery

Crane to be delivered f.o.b. cars, Purchaser's Works.

6. Erection

Erection shall be entirely done by Contractor, by Purchaser, or erected or started under the supervision of Contractor's Superintendent, AS REQUIRED.

Where erection is required by Contractor or Purchaser, all work shall be performed by party specified without recourse to the other party.

Where erection is required under supervision of Contractor, he shall furnish without expense to Purchaser a competent man to superintend the complete erection of crane. Purchaser will furnish all other labor, tackle, etc., required. The Superintendent of Erection shall arrange the work so the erecting crew shall be kept employed to the best advantage during their working hours, otherwise the loss of time will be charged against Contractor; he shall also be responsible for all accidents or damage to persons or property during the erection of, and until the work under this Contract is completed and equipment put into regular service.

Where apparatus is required to be started under Contractor's supervision, he shall furnish without expense to Purchaser, a competent man to check up all work and superintend the starting of the crane.

Contractor shall pay the cost of all fitting or changes made in the field which are rendered necessary by his failure to have done such work correctly in the shop before shipment.

*Supersedes all other crane specifications of the Association of Iron and Steel Electrical Engineers.

7. Guarantee

Contractor shall guarantee to successfully perform the work as outlined and required in this Specification, and to pay all costs of removing, renewing and installing any part or parts which may prove defective in design, material or workmanship before acceptance and within one (1) year after the date crane has been put in operation.

8. Test and Acceptance

Test shall be at the maximum working load of the crane as regards speeds, and such tests must show compliance with the requirements.

Acceptance shall be subject to compliance with these Specifications and Information Sheets, to be determined by inspection after delivery by results of tests above required and upon the approval of Purchaser's Representative.

In case of disagreement between Contractor and Purchaser's Representative in regard to the interpretation of any specification or the compliance of the apparatus furnished with the requirements of this Specification, the question shall be submitted to the engineering department of the purchasing company, whose decision in all such cases shall be final.

If crane is found not to comply with this Specification, the Contractor shall be notified to that effect and shall be required to make apparatus meet the Specification as quickly as possible. Contractor shall proceed with the work within ten days from date of such notice, and if he fails to do so within the time specified, Purchaser reserves the right to make crane comply with the Specification at the expense of the Contractor.

9. Patents

Contractor agrees to pay all royalties on patents embodied in this work, unless released by the Purchaser, in writing, and agrees to assume the defense of any suit or suits for infringement of a patent or patents which may be brought against Purchaser by reason of the use of any apparatus furnished by Contractor, and to indemnify said Purchaser from all loss by damage or costs which may result from a decree or injunction against Purchaser in said suit or suits.

10. Drawings

The Bidder shall submit with proposition three sets of drawings showing general arrangement and detail construction of crane. Immediately after receipt of order and before proceeding with the work, Contractor shall submit to Purchaser for information and criticism a complete set of prints, duplicate of those from which the crane is to be built, but this is not to be considered as relieving the Contractor from responsibility, for design or engineering. Contractor shall furnish Purchaser two complete sets of correct detail working prints and general arrangement on cloth as soon as work has been completed and checked. It is agreed that prints thus furnished will be confidential and will not be exhibited to other crane builders, also that contract shall not be considered as completed or final payment be due until such drawings have been received by the Purchaser.

11. Strength of Material and Factor of Safety

No cast iron shall be used, except for Drums, Collector Shoes and Trolley Collector Hinges, Steel being employed on all other parts.

No Wood, or other combustible material shall be used.

All structural work to be of Open Hearth Steel and physical and chemical properties shall be governed by the Manufacturers' Standard Specifications for Medium Steel.

Proper provision shall be made for all parts subject to impact and rough usage.

Journals and shafts shall be of sufficient size to bring bearing pressures and deflections within safe and practicable limits.

Fiber stress in cast iron shall in no case exceed 2,000 pounds, in tension, or 8,000 pounds in compression.

Fiber stress in cast steel shall in no case exceed 8,000 pounds in tension or 10,000 pounds, in compression.

The physical properties of structural work shall be governed by the Manufacturers' Standard Specifications.

All apparatus not otherwise noted shall be designed throughout with not less than the following factors of safety under full load, based on ultimate strength of material used:

All hooks, etc., not less than	Ten (10)
All gears and complete hoist mechanism, as required	Eight-Ten (8-10)
Worm Gearing	Ten-Twelve (10-12)
Ropes for mill crane, as required	Five-Eight (5-8)
Ropes for hot metal handling crane, as required	Eight-Ten (8-10)
Structural Steel and all other parts, not less than	Five (5)

Calculations for wind pressure on outside cranes shall be based on not less than 30 pounds, per square feet of exposed surface, and on 45 pounds where exposed to storms.

All castings shall be of steel unless otherwise specified, of best material and free from blow holes or other injurious defects.

If purchaser desires a special type of collector shoe, he shall supply builder with drawings of same.

12. Workmanship, Material and Inspection

Workmanship and material shall be first class in every respect, and subject to the inspection of Purchaser's Representative at all times.

Where individual parts of the crane are put together to form a unit, which is shipped and erected as such, the Purchaser shall be notified before this assembly is made, in time to make an inspection of the various parts, if he so desires.

Contractor shall furnish Purchaser's representative with full information concerning the material entering into the construction of this work.

13. Interchangeability

As far as practical, corresponding parts of crane shall be alike and interchangeable.

14. Accessibility

All working parts should be arranged for convenient inspection, lubrication repairs and ease of replacement.

In order to change a shaft, a motor, or a bracket, it shall in no case be necessary to move any part keyed in place, another shaft, motor or bracket.

15. Painting

All parts of the crane to be held in contact by bolts or rivets shall not be painted before assembling.

All structural work and other unfinished parts shall be cleaned thoroughly and given two coats of paint of approved quality, this is to be done on inaccessible parts before assembling, immediately after inspection.

All track wheels, gears, shafting and other machined surfaces shall be properly slushed.

Conductor bars to be painted yellow with the exception of contact surfaces.

No painting shall be done on castings, or finished surfaces until after inspection.

16. Tool and Supply Boxes

Each crane shall be supplied with ⅛" thick sheet steel tool box, of ample size, with hinged lid, fastened to girder side of footwalk, near the landing of ladder or steps.

Each tool box shall be equipped with a full set of jaw wrenches to fit all nuts and bolts on crane and all special socket wrenches for couplings.

All wrenches should be made of pressed or forged steel.

Box for storing oil, grease and waste, made of steel plate and provided with hinged lid, shall be fastened to girder side of foot-walk.

17. Safety Devices

In addition to the safety appliances, such as limit switches, footwalks, gong guards, toe angles, railings, etc., as specified herein, Contractor shall supply all appliances necessary to make the crane comply with the latest Factory Laws of the State in which it is to be operated.

Safety lights indicating that the crane is in operation or idle, shall be installed.

Hoist limit switches shall be mounted directly over the hoisting ropes, so that no sheave wheels are necessary, unless specific permission has been obtained from the purchaser for other type of mounting.

It is recommended that Electrically Operated Track Sanders operated from the cab by the crane operator, shall be provided for sanding the runway rails unless specially omitted by purchasers request.

18. Clearances

Prints showing building clearances will be furnished with Purchaser's Information Sheets. Not less than four inches actual clearance shall be allowed between highest part of crane and roof chord, and not less than 2½" inches actual clearance between any other part of crane and building columns or other stationary structure, where new cranes are installed in old buildings.

For the safety of the men whose duty requires them to work around the crane it is strongly recommended that at least 18 inches be allowed between end of crane and the face of building column and not less than 18 inches between top of crane and bottom of roof truss in designing new buildings.

18½. Worm Gear Drives

As an alternative to the standard Spur gear drive, Worm gear drives may be used, but shall be so designed as to make self locking impossible, under reasonable working conditions and over loads. This unit ratio should be in no case greater than 40 to 1.

The thrust bearings, in all worm drives, shall receive special attention in design and shall be submitted to the Purchaser for criticism, before building the crane.

The bronze rim of the worm gear shall be fastened to the hub or central portion of the wheel, so as to positively prevent it working loose or slipping.

The design of gland and oil seal, where the worm gear is directly mounted on the hoisting drum, shall be given special consideration, to prevent leakage, and shall be submitted to Purchaser for criticism, before proceeding with construction.

19. Bridge Girders

Bridge girders shall be standard type used by crane builders, single structural shape, riveted or welded, AS REQUIRED.

Top and bottom cover plates and angles of box section girders should preferably be in one piece throughout the girder length, but splicing of approved design may be allowed.

Web plates to be not less than 5/16" thick.

The top cover plate of Box girders carrying rails shall preferably be not less than ⅝" and shall be supported at frequent intervals by structural steel distance pieces, which shall bear against it and be riveted or welded to both web plates.

Diaphrams to be provided backing up bridge motor supports over full depth of girder and riveted or welded to these supports and web plates.

Hand-holes to be put in outside web plate near top of girders, to make bolts for rail clamps accessible.

Girders shall be rigidly riveted or welded to end trucks, and be provided on bottom with gusset plates which shall be as large as possible without interfering with the trolley travel.

To further assist in keeping crane "square" and stiff, a heavy angle with foot walk plate, shall be riveted or welded across top of girders at extreme ends, and the entire end of girders covered by a plate riveted or welded to this angle, to vertical angles on end of web plates and riveted or welded to end carriages.

Box Girders shall be drained to prevent accumulation of oil and water, holes to be not less than one inch in diameter.

Where required, a permanent structure supporting beam or beams for use in repairing trolley, shall be located over bridge motor and arranged to allow of its use for repairs on that motor.

This structure shall be capable of lifting the heaviest renewable piece on trolley.

Capacity of each hoist shall be shown in pounds on each side of crane in such a manner as to be easily legible from the floor.

Outrigger girder to be installed to support footwalk and bridge motor.

20. Bridge End Carriages

End carriage shall be of cast steel or structural steel, welded, AS REQUIRED, and duplicate; and they shall be made amply strong to prevent breakage, under most severe strains resulting from legitimate use of crane.

On cast steel trucks driving shaft Bearing Brackets shall be cast intregal with the end carriage, or cast separate in which case they shall be rigidly bolted and keyed to end carriage.

Structural steel end trucks shall have flanges turned out to allow easy access to rivets, and bearings shall be riveted or welded in place.

There shall be a heavy safety lug or strap across the bottom of each carriage near the track-wheel and one inch above the top of rail, to prevent excessive drop in case of breakage of track-wheel, axle or carriage. Wheel base shall not be less than ten (10) feet and must be of ample length on long span cranes.

No part of carriage or track-wheel gears shall project below the flange of track-wheel.

End carriage to be so designed as to permit of easy changing of the wheels. End Trucks to be planed where girders are attached.

Pads shall be provided for use of jacks or wedges when changing track wheels.

Safe means must be provided to give access to compensating trucks and track wheels from track girders.

Guards which will push forward or off the track any object placed across it, like a persons foot or arm, shall be attached to each end of the carriages.

Safe means must be provided to get on the bridge of crane from the crane runway.

All cranes with equalizer trucks shall be provided with steel platforms on inside of carriages, to give access to all wheels and bearings.

21. Bridge Drive

Track-wheels shall be driven through gears pressed and keyed to their axles or hubs, and pinions pressed and keyed to line shaft, which shall run full length of girder and shall be supported by ample number of bearings.

Shafts shall be divided into sections, AS REQUIRED, none to exceed twenty (20) feet in length. End sections to be duplicates.

Track-wheel gears should be inside of end-carriage wherever possible.

Bridge motor, when practical, shall be placed in the center of the bridge girder; supporting brackets shall be of structural material with plate web, and having attachment angles extending the full depth of girder, and over top and bottom cover plate angles riveted or welded to girders.

22. Operator's Cab

All cabs shall be built of structural steel and fireproof material, not less than seven (7') feet high and of dimensions required.

They shall be made substantial and rigid by proper gusset plates and braces welded or riveted, but such bracing shall not interfere with access to cab or vision of operator.

Cab shall also be braced to opposite girders or outrigger girder.

All shall be provided with water tight plate roofs, which shall not slope towards front.

Floor shall not be less than ¼" steel and shall be extended to form a landing platform, which shall be equipped with handrail and toe angle similar to foot-walks and where practicable stairway to foot-walk above shall be located on this platform.

Cranes having cabs subjected to heat from below shall have not less than 3/16" steel shield, six inches below floor proper attached by bolts, having spacing sleeves on them.

Covering of cab floors shall be specified by the Purchaser.

Each cab shall be provided with a conveniently located steel hand or foot operated gong, not less than 12" in diameter, or other suitable warning signal appliance.

Open cabs shall have toe angles around floor, angle to extend not less than six inches above floor coverings, or enclosed 30 inches high AS REQUIRED.

Enclosed cab shall be weather proof, covered with plate and be provided with windows on three sides, which slide or drop completely out of sight and be protected from breakage by a ⅛" sheet steel shield, which if on the inside, shall extend to within two inches of top of floor for windows which drop. If windows slide open, they shall be free to operate and must be so designed that it will be impossible for the sash to fall to the ground, under any circumstances.

All window sash shall be of metal and equipped with clear shatter-proof glass installed from the inside so that if it comes out it will fall in the cab and not to the ground below.

23. Trolleys

Side frames shall be of "I" section Cast Steel secured to cross girts by bolts and key, or structural steel, riveted or welded to cross girts.

The requirements for bridge end-carriage regarding safety lugs and clearances shall be same as for the side frames.

Where practicable, all brackets and bearings shall be permanently attached to frames.

Drum bearings and support for upper sheaves shall be located so as to equalize the load on track-wheels as nearly as possible.

For protection of workmen underneath, not less than 5/16" steel plate, with openings for ropes and toe angles around edges and openings, shall extend underneath the entire trolley.

Track Wheel Bearings are to be designed so as to permit changing wheels by simply relieving bearing of its weight, and shall be M.C.B. or Anti-Friction type.

24. Drums

Where drums are driven through the shaft they shall be double keyed on driving gear end, and shall be designed so as to leave not less than two complete wraps of hoisting rope in grooves when hook is at lowest position, and not require overlapping of rope when hook is in highest position.

Drums shall have turned grooves of depth equal to one-half the diameter of the rope, and a pitch of ⅛" to ¼" greater than this diameter.

Shaft shall be increased in diameter not less than twice the depth of the key seat where attached to drum, or gear.

Drums shall be preferably of steel and have flanged ends of a depth and thickness to suit the size of cable but not less than 1" thickness projecting 2½" beyond body of drum.

Pitch diameter of drum shall be that required by the rope manufacturer for size and kind of rope used, but not less than 30 times the diameter of the hoisting rope.

Where use of lifting magnet is specified, there shall be provided an approved drum with collector rings for handling magnet cable.

Collector rings to be mounted on a metal spider with double insulation; duplicate brushes to be provided to prevent opening of magnet circuit.

Magnet cable shall be attached at center of drum which must be of sufficient length to permit winding of magnet cable in either direction.

Weather protection shall be provided for magnet cable drum on cranes for outdoor service.

25. Ropes

Hoisting ropes to be special flexible plow steel, having six strands, 37 wires to the strand, and with soft steel core.

Where double ropes are provided for safety or for double drive, each rope shall have the same capacity that would be required if only one rope were provided.

Instead of the usual equalizing sheave, equalizing bar may be provided, AS REQUIRED, to which is to be attached the ends of the hoist cables. Equalizing bar to be provided with an anti-friction bearing.

25½. Sheaves, Equalizers and Blocks.

Sheaves shall be bronze bushed or provided with anti-friction bearings and have finished grooves of a depth not less than two times the diameter of the rope.

All sheaves, including equalizer sheaves, shall have a pitch diameter that will comply with the recommendations of the rope manufacturer, but never less than 30 times the diameter of the rope and shall be protected by guards, which fit close to the flanges so as to prevent rope coming off.

Bottom block shall be of structural steel and plates or steel castings, as far as possible, entirely enclosed, and hook shall swivel on ball or other anti-friction bearings so constructed as to exclude dirt.

Hooks shall be of steel forgings, designed with a factor of safety of ten based on the full load capacity of the hoist.

All parts of block shall be so arranged as to be readily lubricated, grease fittings being so located as to be protected from injury as far as practical.

26. Automatic Limits

All hoists shall be provided with dependable, automatic normally closed cutouts, with dynamic braking to prevent over-travel of hook in lifting.

All gantry cranes subject to damage due to excessive misalignment shall be provided with safety limit switches on bridge motion, to provide for this contingency.

Wherever possible crane safety limit switches for hoists should be located directly over the hoisting rope so that no sheave wheels need be used.

When advisable, automatic devices should be provided to prevent cranes from running away under wind pressure.

27. Track Wheels

All track wheels shall be rolled or forged from high carbon (.70 to .80 C) Open Hearth steel, preferably with treated treads unless cast steel wheels are specifically permitted by the purchaser. They shall be pressed and keyed to their shafts.

Both drivers and followers shall not be less than 2" wider than the rail on which they run and shall be finished to a taper of 1" in 16" on the radius, the center of tread being the specified diameter of the wheels, and mounted with the large diameter of wheel toward center of crane.

Flanges shall not be less than 5/8" thick by 7/8" deep, not including fillets and the tread shall be of sufficient thickness to carry rated load when wheels have been reduced 1½" in diameter.

The standard diameter of bridge track wheels shall be 18, 24, 27 and 30" and no rail lighter than 85# shall be used.

The standard bores of these wheels shall be as follows:

18-inch diameter	4 5/8-inch bore
24-inch diameter	5 5/8-inch bore
27-inch diameter	6 5/8-inch bore
30-inch diameter	7 5/8-inch bore

A standard increase in diameter of 1/8" for all bridge track wheel axles in the wheel seat is recommended, preferably the depth of the key seat.

All bridge track wheels on same crane to be interchangeable.

The maximum load on any one track-wheel with trolley fully loaded and at adjacent end of bridge shall not exceed 70,000 pounds, except by written consent of Purchaser, nor shall there be over 650 lbs. per square inch, of projected area on any track-wheel bearing.

The standard tread diameters of trolley track wheels shall be 12, 15, 18, 21 and 24".

The standard bores of these wheels shall be as follows:

12-inch diameter	3 1/8-inch bore
15-inch diameter	3 5/8-inch bore
18-inch diameter	4 5/8-inch bore
21-inch diameter	5 1/8-inch bore
24-inch diameter	5 5/8-inch bore

All track wheels to have hubs of sufficient diameter to prevent cutting into bearing flanges.

28. Track-Wheel Guards.

Substantial fenders or plate guards extending to below top of rail and projecting in front of all bridge and trolley track-wheels shall be rigidly attached to carriage or end frame. They shall be of a shape and form that will tend to push and raise a man's hand, arm, or leg off of rail and away from wheel.

29. Bumpers

Each end of each bridge end-carriage shall be equipped with a substantial bumper of compression spring type, not less than 5", located above rail center line.

Bumpers shall be of sufficient length to prevent any part of either crane being injured when bumpers of two cranes come together.

Trolley bumpers to be of compression spring type, to be attached to bridge girders, and located so as to engage lugs attached to trolley frame.

Where two trolleys are operated on the same bridge, they shall be equipped with spring bumpers on their adjacent ends.

Bumpers to be equipped with safety chains or cables, to prevent them from falling to the ground when knocked loose.

30. Rails

All rails shall be first quality American Standard "T" section, of size required.

Joints shall be made by means of standard splice bars, and provision shall be made to prevent creeping of rails on girders by means of plate riveted or welded to the cover plate or by welding rail itself to cover plate.

Rails shall be fastened in place by steel clamps held by through bolts, or welded, spaced not more than 36 inches on centers, and those on one side shall have a lead of at least three inches over those on the other side, or welded to cover plate.

The trolley rails shall be not less than 60 pounds section, for cranes of 5 tons or over.

31. Foot-Walks

Unless otherwise specified steel foot-walks with rough tread, not less than ½" thick and 24" wide shall be provided on outside of both girders wherever possible, extending to web of the girders and fitted around irregularities and full length of crane, and where practicable, over end carriages and cab making it continuous around top of crane.

Where only practicable to install one such foot-walk it shall be on the side carrying the bridge motor.

When motor is not located entirely below floor of walk, the walk shall be widened at the motor to give a clearance of not less than 15 inches between railing and motor.

Where motor is located partly or entirely below foot-walk it must be surrounded by a plate corresponding to the foot-walk.

Where practicable, walk or girders shall have not less than 6 feet, 6 inches clearance below roof-chord, and the clearance between railing of bridge walk and nearest part of trolley shall not be less than 18".

All exposed sides of foot-walks shall be provided with toe angles which shall extend at least 6" above top of walk, and be not less than 5/16" thick.

Where practicable, a structural foot-walk of same general design 15" wide shall be provided around entire trolley, or at least across both ends.

When practical, platforms shall be provided under each end of the bridge girder to facilitate changing track wheels.

31½. Railings.

Railings shall be provided for foot-walks, preferably made of structural steel, shall be of standard construction, not less than 42 inches high, with toe boards not less than 6 inches high, with intermediate member 21 inches high. Where pipe is allowed no threads shall be cut or threaded fittings used.

Railings shall be provided on girder foot-walks, ends of bridge, landing on cab, and on stairs leading to bridge girder from landing on cab.

32. Stairs and Ladders

Where necessary, steps or ladders, steps preferred, shall be provided to give safe and easy access to girders, end carriages, cab and trolley.

Stair treads shall be of material designed to prevent slipping, and shall not be less than 18 inches in width. Where stairs are not constructed with risers, a plate shield shall be attached to the under side, extending the entire length.

Where ladders must be provided they shall be of steel and constructed with square rungs or have rungs welded to ladder to prevent turning. The rails shall extend 42" above landing place at top, for safety in getting on or off the ladder. They shall start on a landing platform.

Where the slope of stairs exceeds an angle of 55 degrees from the horizontal, ladders shall be used in preference to stairs.

All foot-walks, railings, ladders, or steps, shall be made so as not to interfere with the removal of any part of crane.

33. Castings

All castings shall be made of best material, sound and free from blow holes, shrinkage cracks or other defects. Defective castings shall not be patched or welded without consent of Purchaser's Representative.

34. Brackets

Bearing brackets, if not cast integral with frame, must be kept in alignment by male and female joints or other equally effective method.

No body bound bolts shall be used nor shall bolts be depended on for aligning brackets.

Duplicate brackets are to have holding bolt holes drilled and keys finished to template so as to be interchangeable.

Tie brackets in a single cast piece shall be provided to tie all driving and driven shafts, and shall be located as close as possible to pinion and gear.

Where brackets or other finished parts are attached to structural material, unless such material is of sufficient thickness to allow for finishing, heavy planing strips shall be riveted or welded to structure, which is to be assembled and finished.

Heavy caps shall be provided with eye bolts for lifting.

35. Bearings

All track-wheels not equipped with Anti-friction Bearings shall be provided with M. C. B. type boxes, having hard bronze linings arranged so that they can be lined up to compensate for wear, and provided with large steel oil pockets or cellars filled with either waste, sponges or grease. Oil cellars are to be made oil tight and dust proof as far as practicable.

All bearings, unless Anti-friction bearings are used, except those on motors, sheaves and M. C. B. type, shall be split horizontally and fitted with caps finished male and female accurately bored out, and lined with split hard bronze bushings with flanges on either side to prevent same from falling out, and held from turning by heavy lugs cast on top half.

Bottom half of sleeve bearing shall be so designed as to permit of its removal and renewal without removing shaft.

Bearing pressure on track-wheel brasses shall not exceed 650 lbs. per square inch, except by written consent of Purchaser.

Where Anti-friction bearings are used on crane track-wheels, the trucks shall be accurately machined for the bearing cartridges so that there will be no misalignment. Where these bearings are used on hoist and trolley shafting the trolley shall be preferably a one piece casting with brackets cast integral with, or welded to trolley so as to permit accurate machining. Where these bearings are to be used in connection with a structural trolley, the brackets shall be welded to frame and then bored out for the bearing cartridges.

Bearing pressures on Anti-friction bearings shall not exceed that allowed by the manufacturer of the bearing used.

36. Lubrication

Screw feed compression grease cups, or gravity feed grease cups, or fittings for pressure lubricating systems, shall be furnished for all sleeve bearings. Master Car Builders' type, motor bearings and bearings supplied with ring oilers are excepted.

Cups shall be of not less than 6 ounces capacity for shafts 3 inches and over, in diameter, 3 ounces capacity for shafts 2 inches and under, in diameter and shall be screwed into holding lugs in top half of bearing bushing with ¼" to ½" standard pipe thread.

When grease cups are used, means shall be provided for preventing them from falling, due to becoming unscrewed or broken off.

They shall, as far as possible, be located at points accessible from foot-walks, or provided with extension pipes to bring them within reach of the walk.

Type of grease cups or lubricating system to be specified by Purchaser if there is a preference.

Pressure fittings must have not less than ¼" standard pipe thread.

Where more than one sheave wheel is located on a shaft, each sheave wheel must be provided with individual means of lubrication.

37. Gears and Pinions

All gears and pinions shall be cut to diametrical pitch, Brown and Sharpe standard involute teeth, or 20° "Stub", as required, nothing under 4 Pitch being used. All gears shall be pressed and keyed to their shafts.

All gears and pinions, under 12" diameter, shall be forged of Open Hearth steel and heat treated unless otherwise specified.

All motor gears shall be rolled or forged steel of sizes, as required.

The rim of all gears must be at least equal to the thickness of the teeth, at the pitch line.

No split gears shall be allowed.

Overhung gears, other than armature pinions, shall be used only in exceptional cases, with Purchaser's approval.

The builder shall use the motor manufacturers' standard gear ratios.

On all cranes over 10 tons drum gears shall be pressed on and keyed to the periphery of drum, which must not be reduced more than 1" in diameter where gear is attached.

38. Couplings

Safety flanged, or covered couplings, finished and drilled to Purchaser's standard and template only shall be used.

The same coupling shall be used on all sizes of line shafting from 3⅜" to 4½" diameter inclusive.

Couplings shall be located as close as possible to brackets.

39. Gear Covers

All gears shall be completely covered or guarded by covers, firmly and substantially attached to brackets or other parts of crane, and shall have sufficient clearance to prevent their being struck by any of the enclosed parts, and shall be oil tight.

Covers shall be in two pieces, split horizontally, and so fastened and arranged that top half can be removed for inspection and repairs without disturbing bottom half.

Directly above the mesh line of the teeth, there shall be a hand-hole, with cover held closed by spring hinge.

Gear covers may be cast steel but should preferably be of sheet steel, not less than ⅛" thick, welded inside and outside at corners, and shall be provided with lugs or other means for lifting.

40. Shafting

The diameter of all shafting shall be in even ¼" sizes except that 3⅜" shafting will be accepted.

The minimum diameter of bridge line shafting shall be 3⅜".

End sections of bridge drive shaft shall be 4 feet long and interchangeable.

Middle section shall be at least 8 feet long.

All shafting shall be increased in diameter in ⅛" increments, to twice the key-seat, depth for a distance equal to the length of the hub fit, for gears, pinions, track-wheels or drums and a generous fillet being provided.

All shafting 6 inches diameter and under, not having swells or increases, shall be rolled or drawn; all above that diameter shall be forged and turned to size.

Diameter of all motor axle shafts shall be AS REQUIRED.

41. Force Fits

All connections subject to torsion shall be pressed or shrunk on and keyed in place.

Press fits shall be made with a pressure of not less than ten tons per inch of shaft diameter.

42. Keys

All keys, wherever possible, except feathers, shall be made with standard taper. Keys to be secured in approved manner to prevent the possibility of working loose. Projecting keys shall be covered, or otherwise protected.

43. Bolts, Nuts and Rivets

All bolts, except those in couplings shall be rough machine bolts and all bolts shall have U. S. Standard thread, with cold pressed hexagon nuts.

They shall be provided with cotter pins, lock nuts and spring lock washers, and heads held from turning by recess or projecting lugs.

No studs, cap-screws or body bound bolts, except on couplings shall be used without the written consent of Purchaser's representative, after detailed explanation of the necessities has been made.

No bolts, except those used in safety flange couplings, shall be so located as to require the use of socket or other special wrench.

In all structural work, such as gusset plates, brackets supporting foot-walks and bridge-line shaft, angles supporting operator's cab and all other parts, unless welded, rivets shall be used instead of bolts, wherever possible.

All bolts, when drawn up tight in position, shall extend beyond the nut and be drilled for cotter pins of proper size, not to act as a lock, but to prevent either the nut or bolt from falling to the ground in case the nut works loose in service.

44. Brakes

Brakes complying with the following requirements shall be supplied for hoists.

A. Mechanical retaining brake, as required.

B. Electro-dynamic braking control.

C. Magnet brake on commutator-end extension of armature shaft.

D. Auxiliary magnet brake located on shaft as close as practicable to drum.

For Bridge

Foot operated brake on commutator-end extension of armature shaft, with foot-lever conveniently located for operator and arranged to be fastened in "on" position.

With 100 lbs. pressure on foot lever, bridge foot-brakes shall stop crane within a distance in feet equal to 10% of full load speed in feet per minute when traveling at full speed with full load.

Where operator travels with the trolley, on cranes or charging machines, a shunt or series wound brake, as specified, must be installed on the bridge motor.

Where cranes are equipped with anti-friction bearings a magnetic brake must be installed on the trolley motor.

Any apparatus, such as brake rigging, attached to, or supported on motor, shall be arranged so that removal or loosening from motor frame shall not be necessary in order to change the armature.

Each brake shall be capable of retarding full load, lowered at twice the hoist speed, and holding same when stopped, unassisted by other brakes.

Brake wheels shall be accurately balanced.

Brakes for same size motor shall be alike, and interchangeable.

D.C. solenoids shall be single spool, with coil wound on heavy cast shell and protected from the weather by metal casing.

Winding shall be of fireproof insulated wire or strap, which in case of series coils shall have cross section not less than that of the motor fields with which they are in series with an allowable temperature rise equal to that of the motor fields. No round wire larger than No. 1 B.&S. gauge will be used.

A.C. coils shall be single phase, have fireproof insulation throughout and be held rigidly on cores.

Means shall be provided to prevent any parts of brake from falling to the ground in case they become detached, or broken.

Mechanical retaining brake, if specified shall be simple in design so as to necessitate minimum attention, and of sufficient capacity to absolutely prevent load from lowering unless motor is revolved by power in the lowering direction.

Unless otherwise specified, and where direct current is used, lowering shall be by electro-dynamic control, with one magnetic brake on armature shaft of hoist motor.

Where electro-dynamic brake is required, lowering speed with full load on hook shall be limited to twice the normal full load speed of armature.

45. Conductors

Conductors across the bridge shall be of rigid type. (Copper bar.)

Main conductors and collectors for longitudinal travel of cranes will be furnished and installed by Purchaser.

Trolley cross travel conductors and collectors shall be furnished and installed by Contractor.

Conductors shall be located preferably above girders along foot-walks on opposite side of bridge motor so that hoisting rope cannot come in contact with them under any operating condition, and shall be of a section, AS REQUIRED.

All collector rail joints, if used, shall be welded, or bonded, with welded bonds of standard quality.

46. Motors

Motor Ratings to be determined by the use of the American Institute of Electrical Engineers' Standards for Railway Motors, which shall be the basis for determining the sizes unless motors are specified by the Purchaser.

They shall be provided with feet and the contractor shall furnish the motors with axle bearings to support the jack shaft or motors without axle bearings equipped with flexible coupling and gear reduction in oil tight gear box, as specified.

Motors without axle bearings should be machined on each side of the motor feet to fit between machined lugs cast or welded to the motor base plate to eliminate the shear on the motor bolts.

No pinion shall be located on commutator end of shaft, except with consent of Purchaser.

All bearings shall be ring-oiling, or Anti-friction bearing, AS REQUIRED, and armature shafts shall be provided with standard extensions, straight or tapered, AS REQUIRED, whether equipped with brake-wheel or not.

All motors shall be mounted horizontally.

All bolt holes in feet shall be supplied with bolts.

When practicable, motors shall be arranged so that sufficient clearance is allowed, when changing armature, to swing top half of motors on their hinges.

47. Controllers*

Controllers may be furnished by Purchaser, AS REQUIRED, in which case all data regarding same necessary to design cab, foot-walk, conductors, sup-

ports, etc., will be supplied to Contractor by Purchaser.

Purchaser may specify or approve type, make and size, of motors and controllers to be used.

Where controllers are located on foot-walk, Purchaser should state whether cranes are under cover or exposed to weather so that proper provision can be made to protect same.

Controllers must be equipped with unbreakable resistance.

*Guide forms for ordering controllers for Crane Service may be obtained from the office of the Association of Iron and Steel Electrical Engineers, if desired.

48. Crane Protective Panels.

A protective panel is required as part of the crane control equipment to provide overload and undervoltage protection by means of a single unit to all of the motors on a crane, unless this protective apparatus is included on the individual control panels, and shall conform to the standard rules of the National Electrical Manufacturers Association.

Crane Protective Panel should be placed in rear of cage and contain the following equipment:

(a) Two single pole or one double pole main line contactors for opening both sides of the line.

The continuous capacity of the main line contactors shall not be less than 50 per cent of the combined one-half hour rating of the motors, nor less than 75 per cent of the one-half hour rating of the largest individual motor.

(b) A double pole line knife switch with provision for locking in the open position and shall have carrying capacity not less than that specified above for the main line contactors.

(c) Overload protection relays shall be provided for each motor by either double overload relays, or single overload relay for each motor circuit and one overload relay in the common return circuit.

(d) The control circuit system shall be protected by at least one fuse in each side of the line.

(e) Two pilot light receptacles are to be provided, fused and connected to the line wires outside of the line switch.

(f) Equipment should be protected with a readily removable cover and provision made for external operation and locking of the main line knife switch.

(g) A safety and reset push button station shall be provided for opening and closing the line contactors of the protective panel.

All cranes must be equipped with an enclosed double pole safety switch, mounted on the foot-walk adjacent to the cab, so connected that it will disconnect the main circuit between the collectors and the switchboard and arranged to be locked open.

Location and type to be specified by the Purchaser.

48½. Wiring

All wiring must be flexible stranded rubber covered with fire-proof finish and be placed in approved rigid conduits, which should be continuous to switch boxes or conduit outlets, etc., so that there are no bare terminals exposed.

All conduits must be clamped solid to crane to prevent vibration from wearing insulation off, and to be carefully bushed where wires enter same, and should be grounded to the metal crane. Each motor must be wired independent. No common return for two or more motors to be used. No flexible steel conduit to be used, except where cabins or cages are subject to unusual vibration; conduit may be terminated by substantial supports on crane and cage, and approved flexible armored cable provided for protection of the wires.

Wiring between connections on resistance must be run in asbestos or fibre tubes, or be bare of insulation.

Wires running from controller to resistance, inside cages, that are not subject to any direct injury, should be of fireproof insulation, and made into cable, taped with asbestos tape and painted with insulating varnish.

Wiring and all other electrical apparatus may be furnished by, and all wiring be done by the Purchaser.

Purchaser shall submit wiring specifications, where the contractor is to wire up the crane.

APPENDIX A

HOT METAL CRANES AND HOOKS

1. For Cranes Handling Hot Metal the Following Additional Specifications Shall Apply.

2. Operator's Cab

(A) Operator's Cabs shall be so constructed that in case of spills the operator may completely enclose himself by means of doors, and steel protecting shields over the windows.

(B) When crane is handling molten metal, provision must be made for the quick escape of operator, by runway or other means, in case molten metal gets spilled.

(C) Cab that will be subject to heat from below, shall have a shield plate not less than 3/16" thick, 6" below floor of cab, attached by bolts having spacing sleeves on them.

(D) Hooks.

Ladle Hooks

All hooks for handling hot metal ladles, shall be of laminated construction, the center plates being not less than ½" thick, which shall be reinforced by side plates, not less than 1" thick and all held together by machine finished, soft iron counter sunk head rivets, which shall be a driving fit in drilled holes and riveted cold.

Standard medium open hearth steel shall be used and have a tensile strength of from 60,000 to 72,000 pounds per square inch, as rolled and should be thoroughly annealed at a temperature between 1525 and 1575 degrees Fahrenheit, after being built up and machined.

NOTE: This tensile should lie within the range of .20 to .30 C. (Not over .35 C) .50 to .80 Mn and after annealing should result in a tensile of from 55,000 to 65,000 pounds per square inch.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS
CRANE SPECIFICATIONS

.....WORKS....., 19.....

SERIAL NO.....

SPECIFIC INFORMATION COVERING ELECTRIC CRANES
(This information to be furnished Bidder by Purchaser)

Contractor shall furnish.....Electric Cranes of.....lbs. capacity.

No proposition will be considered which does not comply with all the requirements of the attached agreement.

Item numbers in the following are the same as corresponding section numbers of the General Crane Specifications.

General		
	Number of cranes	
	Where used	
	Duty	
	Building clearances, Drawing No.	
Capacity		
	Maximum working load of:—	
	Main hoist	lbs.
	First auxiliary hoist	lbs.
	Second auxiliary hoist	lbs.
Dimensions		
	Span center-line to center-line to bridge runway rails	
	Total lift of main hoist	
	Total lift of first auxiliary hoist	
	Total lift of second auxiliary hoist	
	Minimum distance from center-line of main hoist hook to center-line of bridge rail on cage end.	
	Minimum distance from center-line of first auxiliary hook to center-line of bridge rail on cage end	
	Minimum distance from center-line of second auxiliary hook to center-line of bridge rail on cage end	
	Minimum distance from center-line of main hoist hook to center-line of bridge rail on side opposite cage	
	Minimum distance from center-line of first auxiliary hook to center-line of bridge rail on side opposite cage	
	Minimum distance from center-line of second auxiliary hook to center-line of bridge rail on side opposite cage	
Speeds		
	Full load speed of main hoist	
	" " " " first auxiliary hoist	
	" " " " second " "	
	" " " " bridge	
	" " " " main trolley	
	" " " " auxiliary trolley	
6.	**Erection**	
	Crane shall be erected by	
19.	**Bridge Girders**	
	Is structure over trolley to be supplied?	
20.	**Bridge End-Carriages**	
	Cast or structural steel? Welded or Riveted	

21. Bridge Drive
Length of sections to be as follows:—

22. Operator's Cab
Open or closed

Kind of floor

Special features

23. Trolley
Is side frame to be of cast or structural steel?
Welded or Riveted

24. Drums
Is lifting magnet used on crane?

25. Ropes, Sheaves and Blocks
Kind of rope

Hooks to be in accordance with print No.

26. Automatic Limits
Style automatic limits

30. Rails
Size rails bridge runway

Size rails main trolley runway

Size rails auxiliary trolley runway

35. Bearings
M. C. B. type bearings to be furnished on

Grease cups to be furnished on

Anti-friction to be furnished on
Oil-rings to be furnished on

37. Gears and Pinions (Pitch and No. of teeth)
Main hoist motor

First auxiliary hoist motor

Second auxiliary hoist motor

Bridge motor

Main trolley motor

Auxiliary trolley motor

38. Couplings
All couplings in accordance with print No.

40. Shafting (Motor Axle)
Main hoist motor Dia.

First auxiliary hoist motor Dia.

Second auxiliary hoist motor Dia.

Bridge motor Dia.

Main trolley motor Dia.

Auxiliary trolley motor Dia.

42. Keys
Keys and keyways in accordance with print No.

44. Brakes (type of brake and brake lining)
Main hoist

First auxiliary hoist

Second auxiliary hoist

Bridge

Main trolley

Auxiliary trolley

45. Conductors
For type of conductors, supports and collectors, see Drawing No.

46. Motors
Standard enclosed crane motors of following types and sizes to be furnished:

Main hoist

First auxiliary hoist

Second auxiliary hoist

Bridge

SERIAL No. ..... , 19....

SPECIFIC INFORMATION COVERING ELECTRIC CRANES

(This information to be furnished Bidder by Purchaser)

Main trolley

Auxiliary trolley

47. Controllers
Controllers shall be furnished by

48. Wiring
Wiring, switchboard and other electrical apparatus shall be furnished by

49. Special Features

..... WORKS ....., 19....

SERIAL No. ..... SERIAL No. .....

SPECIFIC INFORMATION COVERING ELECTRIC CRANES

(This information to be furnished Purchaser by Bidder)

Complete set of information sheets to be filled out by Bidder in the two columns for each different size and kind of crane bid upon

	Column 1	Column 2
General		
1. Bidder		
2. Date of proposition		
3. Total weight of crane exclusive of motors		
4. Total price f. o. b. Purchaser's works		
5. Price per lb. exclusive of motors		
6. Time of delivery in weeks		
Clearances		
7. Total height of trolley above trolley runway rail		
8. Distance of trolley runway rail to bridge runway rail		
9. Distance from center between bridge girders and extreme outside of cage		
10. Distance from center between bridge girders and extreme outside of crane on side opposite cab		
11. Minimum center to center distance of two of these cranes on same runway		
12. Distance from top of trolley runway rail to bottom of cab		
13. Minimum safe working distance between top of trolley runway rails and highest point of main hoist hook		

	Column 1	Column 2
14. Minimum safe working distance between top of trolley runway rails and highest point of first auxiliary hoist hook		
15. Minimum safe working distance between top of trolley runway rail and highest point of second auxiliary hoist hook		
NOTE Bridge runway rail on cab end to be called "A," on opposite end to be called "B"		
16. Minimum distance center of main hoist hook to center of rail "A"		
17. Minimum distance center of main hoist hook to center of rail "B"		
18. Minimum distance center of first auxiliary hoist hook to center of rail "A"		
19. Minimum distance center of first auxiliary hoist hook to center of rail "B"		
20. Minimum distance center of second auxiliary hoist hook to center of rail "A"		
21. Minimum distance center of second auxiliary hoist hook to center of rail "B"		
22. Distance between center of main and first auxiliary hoist hooks		
Girders		
23. Type of girders (Box, I or Lattice) Riveted or Welded		
24. Number of girders		
25. Distance center to center of girders		
26. Maximum deflection of girders with full loads (all hoists) at center of bridge span		
27. Weight of bridge complete without trolleys		
End-Carriages		
28. Type of end-carriage (cast or structural) Riveted or Welded		
29. Number of track-wheels on one carriage		
30. Diameter of track-wheels		
31. Wheel base (two wheel carriage)		
32. Wheel base of outside wheels (four wheel carriage)		
33. Wheel base of inside wheels (four wheel carriage)		
34. Weight of end-carriage complete		
35. Maximum load on one end-carriage wheel		
36. Size of end-carriage wheel bearings		
37. Maximum pressure on track-wheel bearings		
Bridge		
38. Diameter of bridge line shaft		
Main Trolley		
39. Is trolley reversible?		
40. Type side frame (cast or structural) Riveted or Welded		

SERIAL No..... ....., 19.....

SPECIFIC INFORMATION COVERING ELECTRIC CRANES

SERIAL No.....

(This information to be furnished Purchaser by Bidder)

		Column 1	Column 2
	Bidder		
41.	Diameter of track-wheels		
42.	Wheel base		
43.	Span		
44.	Total weight		
45.	Maximum load on one wheel		
46.	Maximum pressure on track-wheel bearings		
Auxiliary Trolley			
47.	Is trolley reversible?		
48.	Type side frame (cast or structural) Riveted or Welded		
49.	Diameter of track-wheels		
50.	Wheel base		
51.	Span		
52.	Total weight		
53.	Maximum load on one wheel		
54.	Maximum pressure on track-wheel bearings		
Main Hoist			
55.	Number of drums		
56.	Diameter of drums		
57.	Total number of gear reductions		
58.	Minimum diameter of sheaves		
59.	Diameter of rope		
60.	Total length of rope (if rope is in more than one piece, give length of each piece and number of such pieces)		
61.	Number of ropes supporting load		
62.	Approximate speed, light load		
First Auxiliary Hoist			
63.	Number of drums		
64.	Diameter of drums		
65.	Total number of gear reductions		
66.	Minimum diameter of sheaves		
67.	Diameter of rope		
68.	Total length of rope (if rope is in more than one piece, give length of each piece and number of such pieces)		
69.	Number of ropes supporting load		
70.	Approximate speed, light load		
Second Auxiliary Hoist			
71.	Number of drums		
72.	Diameter of drums		
73.	Total number of gear reductions		
74.	Minimum diameter of sheaves		
75.	Diameter of rope		
76.	Total length of rope (if rope is in more than one piece, give length of each piece and number of such pieces)		
77.	**Number of ropes supporting load**		
78.	**Approximate speed light load**		